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SEPTEMBER 1998

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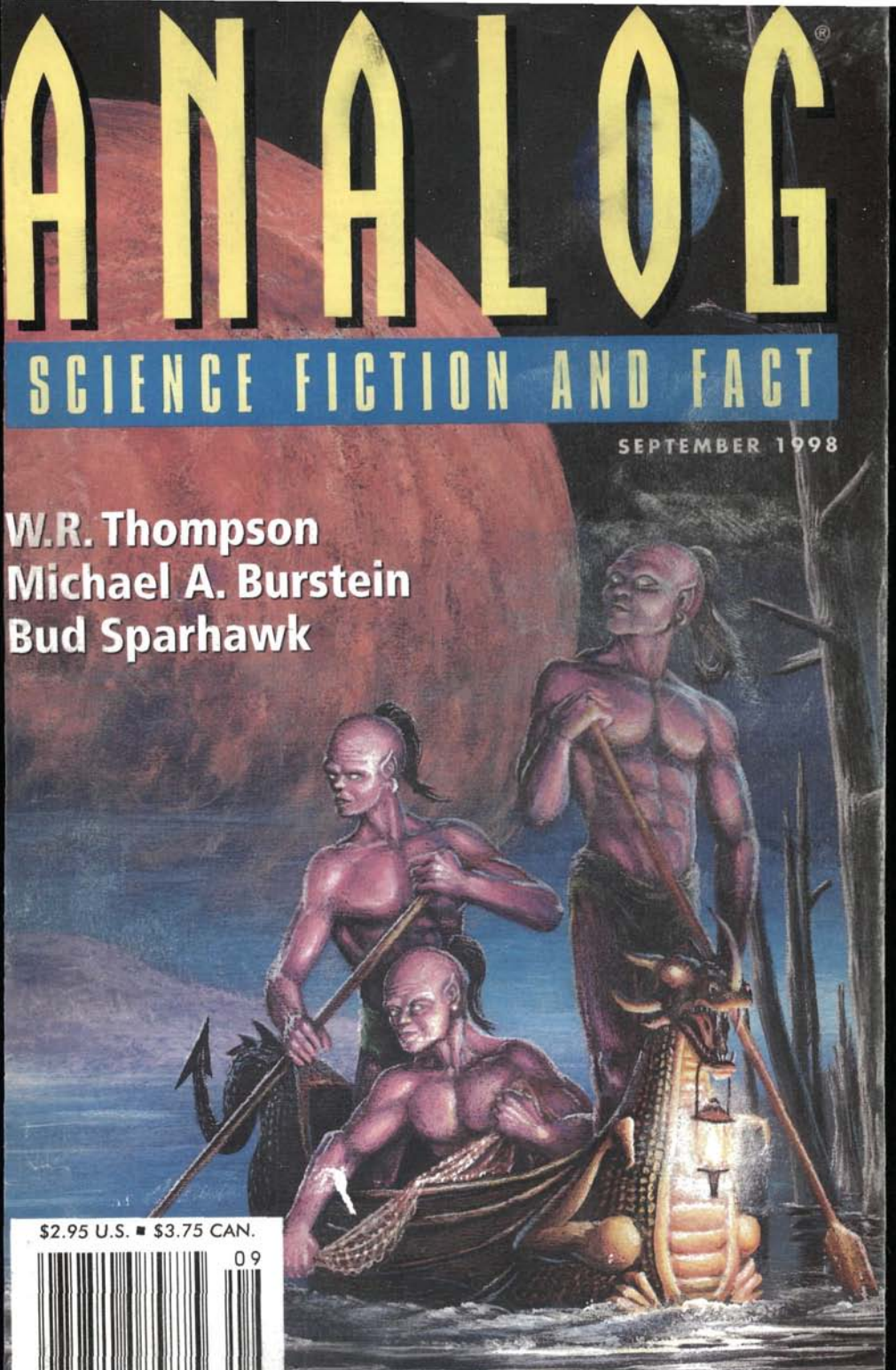

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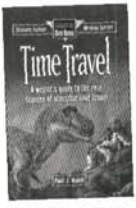

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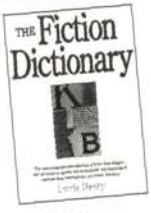

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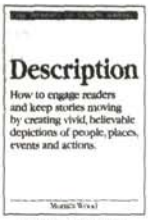
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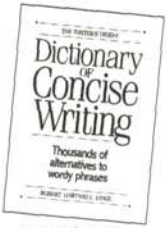

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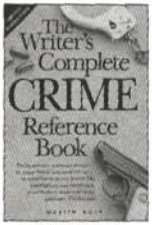

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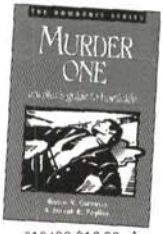

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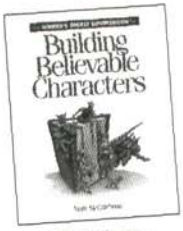

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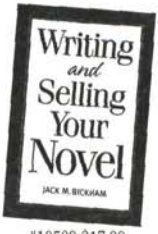

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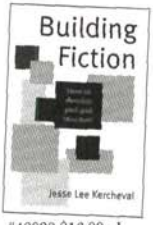

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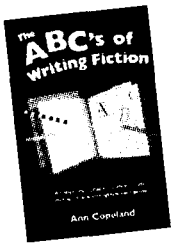

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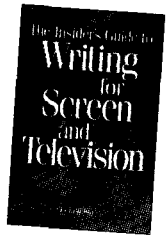

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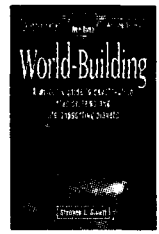

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EDITORIAL Stanley Schmidt

INVISIBLE ENEMIES, INTELLIGENT CHOICES

Americans' reactions to "evil spirits," whether the term is used literally or to refer to other threats not seen directly, such as microorganisms and radiation, continue to be one of our more reliable sources of amusement—and, on reflection, concern.

Take, for example, last year, when a couple of batches of ground beef were recalled because they were found to be contaminated with the bacterium *Escherichia coli*, a potential cause of gastronintestinal disease. The incidents were widely publicized, and widely followed by what can most charitably be described as panic. Beef sales dipped sharply, not just at the clearly identified suppliers that had the problem, but generally. Some people swore they would never eat beef again (though following up on how many *kept* that resolve might be another source of amusement).

Hardly anybody seemed to have the slightest grasp of the fact that the problem here was *E. coli*, not beef, or the fact that neither is necessarily associated with the other. There's no reason why beef *has* to be contaminated with *E. coli*, if it's processed and packed properly; and there's no reason why *E. coli* needs beef to be introduced into the human system. It can just as well ride on any number of other foods. (Actually, *E. coli* is a perfectly normal, permanent resident of the human digestive system. The problem with contaminated food is that its passengers may be a strain to which a particular immune system isn't acclimated, or they may be so numerous that they overwhelm the body's usually effective defenses.) All that seems to be much too involved for John and Jane Q. Public. Give a little publicity to one contaminated batch of *something*, and they promptly jump onto the Bandwagon du Jour: mortal dread at that something, with little or no attempt to understand the real (albeit invisible) danger.

It got even more interesting when people who were expected to do something about the problem proposed fighting one invisible enemy with another invisible thing that is also widely (albeit fuzzily) seen as an enemy. The Food and Drug Administration approved the use of irradiation, like that already approved but not widely adopted for treating certain other foods, to kill bacteria like *E. coli* and salmonella in beef. "The use of irradiation to deal with an otherwise intractable health problem is not only acceptable, but desirable," quoth one public health official.

But he obviously faced an uphill battle in getting the public to accept that notion, and the article in which I read his quote was just full of gems. One meat market owner said the use of irradiation would only hurt the meat industry, which, in the words of the article, was "already suffering from poor quality meat and poor packaging that can lead to contamination."

Which, of course, are exactly the problems that irradiation is intended to solve, and has shown itself, in several lab studies, to be quite capable of solving. The virtue of irradiation is that it can sterilize meat *after it has been packaged*, so it will

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stay sterilized, and without any known adverse effects on the food itself or anyone eating it. But that meat marketer is probably right about the prospects. When it comes to the public and anything containing the syllables "radiation," facts and logic have nothing to do with the case. People would much rather keep subjecting themselves to (and grumbling about) an invisible enemy that they know makes people sick and occasionally kills them, than fight it with something equally invisible that has never killed anybody and has so far shown no evidence that it ever will.

One shopper interviewed at a supermarket was quoted as saying, "When I think of radiation, I think of cancer. What's better, to die from radiation or *E. coli*?" Never mind that radiation is sometimes used (successfully) to *treat* cancer, or that the right kind of radiation used appropriately on *food* isn't going to kill *anybody*—and that a quick trip to the library, or any number of web sites, could make that quite clear.

A health commissioner correctly pointed out that, "Irradiating food is totally different from irradiating people. Irradiating food kills organisms that are harmful to people." But the reporter quoting him opined that the public would be hard to convince, adding, "After all, gamma rays are credited with turning comic book character Bruce Banner into the Hulk."

And in that sentence we see laid bare yet another invisible enemy that in the long run may do us far more harm than either microorganisms or radiation: galloping ignorance and sloppy thinking. The reporter didn't attribute that line to any particular individual, and my first reaction was to laugh at it. Then I realized that a great many people really would find that sentence about the Hulk at least as convincing as anything scientific "authorities" might tell them.

That is the invisible enemy I'm writing about here. *E. coli* and food irradiation are just recent examples of its *modus operandi*, not major issues in themselves. Personally, on the basis of what I've read, I'd like to have irradiated food available as an option; but promoting it is not by any means the main reason I'm writing this. I'm writing because there are so many things of comparable importance, and so many people who have vehement opinions about them despite having little or no understanding of them.

We may or may not need irradiation of food. We certainly and urgently need much better science education, in terms of both facts and attitudes.

Whether or not to accept and use any technology (of which food irradiation is just one example) is a choice, to be made by individuals and/or groups. As with any choice, I'd prefer that it be made individually whenever possible; there's simply no justification for my making a choice that affects only you, or vice versa. Irradiation is a case where the choice can be individual: If both irradiated and unirradiated foods are available, individuals can choose whichever they prefer, without any group imposing its tastes or prejudices on others.

There are, of course, other situations in which choices cannot be left entirely to individuals. Dumping untreated sewage into public water supplies, for example, does not have to be tolerated

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just because somebody feels like doing it, because its consequences clearly affect other people—who therefore have a legitimate say in whether it should be done. An interesting problem, of potentially life-and-death significance, can and does arise in such decisions: What if an ignorant majority believes it's perfectly all right to dump untreated sewage in the water supply, but an informed minority knows it isn't?

Whether decisions about a particular technology can be left to individuals, or must involve a larger group, the point is that there is a choice to be made. Therein lies one of the crucial distinctions between science and technology. We get a choice about technology, but nobody gets a choice about about whether to obey natural law, which is indeed imposed upon us by a thoroughly inflexible Higher Power.

And choices about technology depend, among other things, on natural law (or, if you prefer, scientific principles). They cannot be made wisely without at least some understanding of those principles.

Please note carefully: I am not saying that all that matters about a technology is whether the hardware works, or that people should adjust to technology rather than technology to people. Of course technologies should be chosen and adapted to human needs—but a person with no understanding of how they work cannot realistically hope to do that. (Nor, of course, can a person with no understanding of human needs.)

Individuals and societies should, to the greatest degree possible, have the option of choosing the kinds and amounts of technology they want—but I'd like to be sure they are able to make those choices rationally. If the choice is purely individual, I won't even insist on that. If some people want to make their personal choices with no regard for facts or logic, far be it from me to deny them that choice. But even that should be an informed choice, and it can't be if they know nothing of the facts or how to think logically. So, yes, I would like to see everybody's education include some solid grounding in principles of science and logic—so that even if they decide to reject it, they at least know what they're rejecting.

And if their choices affect not just themselves, but others—you and me, for example—then I *really* want those choices to be as informed as possible. If people want to make their own decisions on the basis of pure emotion, without any regard for whether they make sense on the basis of real principles or relationships, that's their business. But decisions that affect everybody are everybody's business, and the idea that anybody's opinion is as good as anybody else's just doesn't hold water. ■

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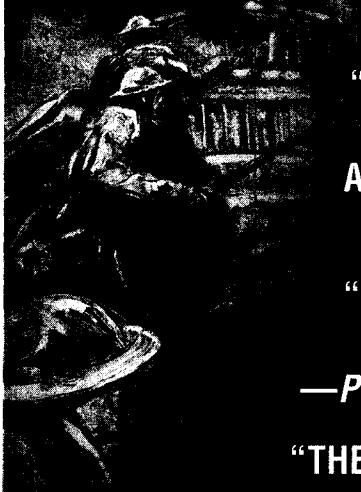

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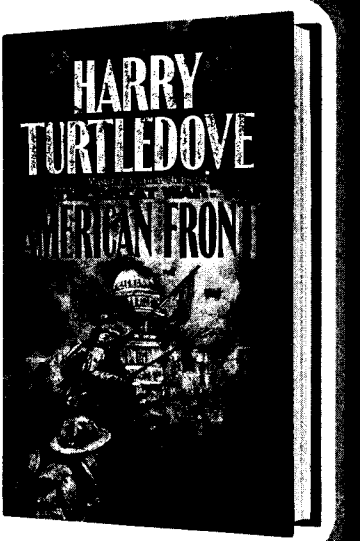

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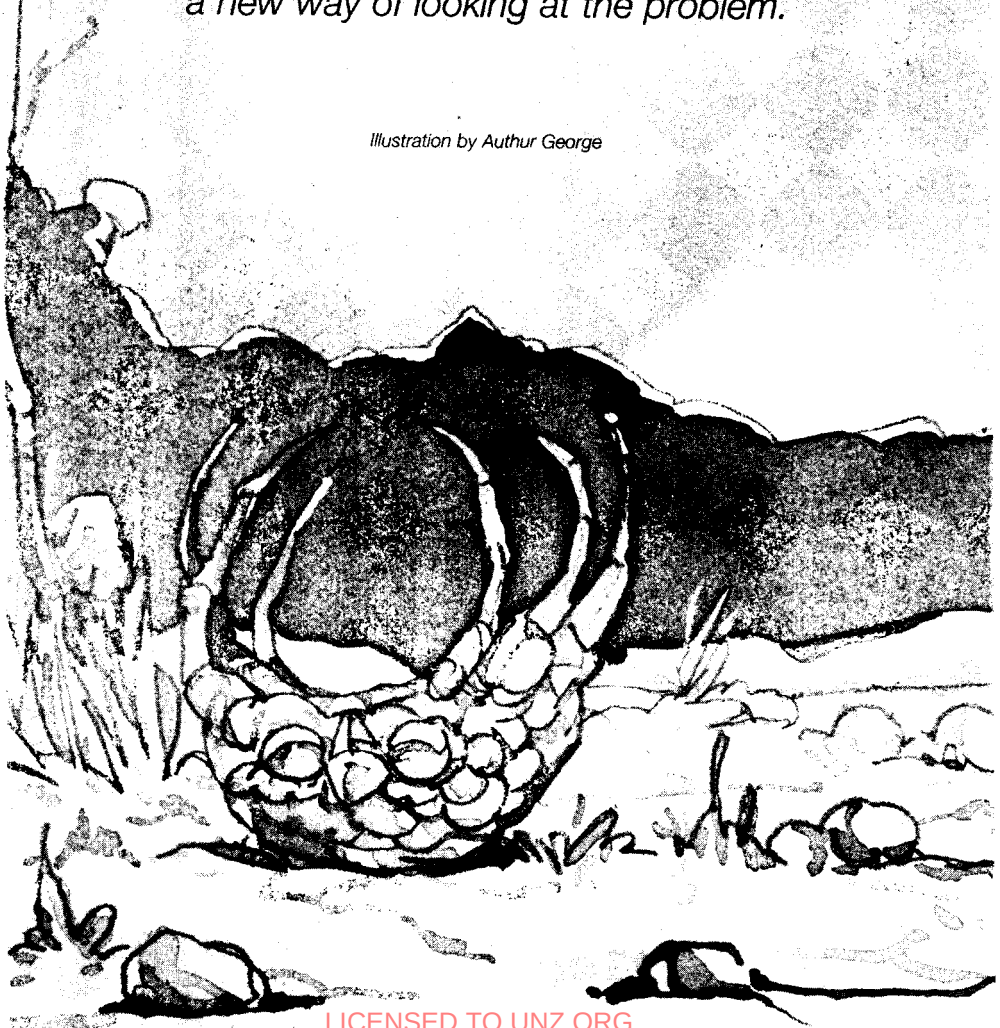
W.R. Thompson

ROUNDUP

Sometimes resolving an "irreconcilable" conflict just requires a new way of looking at the problem.

Illustration by Authur George



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"The invaders have been on Kya *three months*," the man said angrily. He seemed ready to jump out of the screen and pound on Delores Jones' desk. "*Three months*. The kya can't stop them. When is the UN going to *fight*?"

"I'm sorry, sir." Delores struggled to sound pleasant and sincere in the face of the businessman's wrath. You'd think he was here on Kya, she mused, not safely back on Earth. "I can't discuss the war."

"*What* war?" the man demanded. "Those monsters have taken half of Kya without a fight! All the kya do is pull back, go home and graze. And I don't see the UN doing a damned thing to protect my investments!"

Delores ordered herself to be patient. "Sir, the UN is doing—"

"—nothing," the man growled, and broke the connection.

"Jerk," Delores muttered. She was fed up with calls from people who thought that the war existed to inconvenience them and that the UN embassy could make it all go away. As the embassy's operations officer—a fancy title for girl Friday, she reflected—such things went with the job. Liking such things was another matter.

She looked at the map on the lobby wall. It wasn't true that the aliens occupied half of Kya. The latest reports said they held about ten thousand square kilometers of desert land near the equator, marked on the map as a cross-hatched circle a hundred klicks in diameter. What they did in those lands was anyone's guess; the aliens vaporized anything that approached them. The kya's tiny army had shown the good sense to do nothing more than patrol the edge of the occupied territory.

Humanity had accomplished nothing yet. Before the invaders' ship landed on Kya it blasted the satellites which the UN had placed in orbit, making orbital surveillance of the invaders impossible. It then shot down a starship that tried to enter Kya orbit, and that attack had caused the UN to cancel all further flights to Kya. The human scientists on Kya had set up an observation post outside the invasion zone, but if they had learned much about the invaders Delores didn't know about it. Security was tight.

And it was none of her business, she mused. Her job was to keep the embassy running. Let the higher-ups worry about the war.

Ambassador Nyquist opened his office door and peered into the lobby, looking for all the world like a nervous mouse checking for cats. "Trouble?" he asked.

"Just another call from Earth, sir," Delores said. "A perfume importer wanted to know about the war."

"You mean he wanted to know when we're going to break the blockade and let him start making a profit again." Nyquist laughed in derision as Delores nodded. Then he handed her a note pad. "We may have good news for him."

Delores took the pad, touched its display key and read its message. The UN had devised a plan to defeat the invaders; details would arrive soon. The UN anticipated that it could eliminate the invaders with negligible upset to the natives and environment of Kya. Nyquist was authorized to divulge this information to the leaders of the kya overgovernment.

Delores looked up from the pad and its good news. "I take it this is secret?"

"Quite," the ambassador said. "Earth doesn't think the enemy can intercept our tachyon laser, so our link with home is secure. But the invaders use radio, so if the kya learn this—"

"—the invaders could hear it on their broadcasts," Delores finished. That assumed they could understand Wideplain, the major kya language, but that seemed a safe assumption. Any reasonable invaders would study their victims.

"Precisely," Nyquist said. "Arrange a briefing for the local chieftains—and their scientists," he added. "They won't

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understand anything, but it'll make a good impression on them. Schedule it for, oh, the day after tomorrow."

Delores nodded. "Sir, when *can* we expect help to arrive?"

Nyquist smiled slightly. "I'm not authorized to say—but I *can* say you'll be pleasantly surprised." He returned to his office.

Delores accepted that answer and set to work, composing an invitation to kya politicians and scientists. Once that was done she carried her deskpad into the factory room, where she fed the message and the embassy's mailing list into a nanotech duplicator. The machine extracted raw materials from its supply tanks, and a moment later it opened to reveal a pile of stamped, sealed envelopes. Delores picked them up—and found that the duplicator had fused them into a solid mass of paper.

With a sigh she touched the intercom pad. "Kakuji? I need you in here."

Kakuji Saito entered the room a moment later. "Trouble?" the young computer technician asked. He shook his head as Delores handed him the letters. "I could have sworn I worked the glitches out of the system."

"You aren't the first tech this duplicator has defeated." Delores reminded herself that Saito was relatively new; he had landed on Kya only weeks before the invasion, and the UN had hired him straight out of college. "Call me when you have it fixed, okay?"

"I'll only need a minute," Saito told her.

"Call me," Delores said, biting back a comment about his optimism. Shaking her head, Delores returned to her desk, where the phone was ringing again. The call came from a London travel agent who wanted to know why the UN was trying to bankrupt him by suspending travel to Kya.

It was late in the evening when Delores went home, riding her electric scooter under a mercifully cloudy sky. While Kya had a thick ozone layer, enough ultraviolet light from its energetic star got through to present Delores with a sunburn whenever she forgot to use her sunblock. The curse of being part Irish, she thought; red hair and fair skin weren't meant for some parts of the universe.

Jan Jones didn't have that problem. Her olive complexion took well to the light—very well, Delores reflected in admiration as she parked her scooter. The statuesque sports reporter was in the front yard, pushing an imported lawn mower with the same vigor that had won her a gold medal at the '36 Olympics. Delores' assignment to Kya had seemed like a hardship duty, before Jan's arrival had brought them together.

Delores waited until Jan pushed the lawnmower near her. "You're home early," Delores said. Jan was supposed to be a third of the way around the planet, covering a bagdrag game. The kya game had a faddish popularity on Earth, and her network was cashing in on that.

"They canceled the game," Jan said. She gave the lawn mower a final push, then stopped. "Xlot'g Tech couldn't make it. The college is near the invasion zone, and their schedule is a mess."

"It can't be helped," Delores said. "Look, they'll reschedule the game—"

"I know," Jan said. "That isn't the problem. The problem is that this invasion is news, I'm the only human reporter on Kya, and the UN won't let me report on it! 'Security,' they call it. Security for *what*?"

"They're afraid the invaders could monitor your broadcasts," Delores said. "That—"

"I know," Jan said in frustration. "I've heard Nyquist's lecture. Military security! That overbearing scuzzball *enjoys* playing soldier—or dictator." Jan gritted her teeth and started pushing the lawnmower again.

Delores watched her move across the lawn. Jan was getting moodier every day, withdrawing into an angry gloom at her

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inability to get the news out. Delores had tried to pull her out of her depression, but so far her efforts had failed. If I want our marriage to last, she thought, I'd better think of something good, and fast.

Delores was still watching Jan mow the lawn when one of the neighbors appeared. Like all kya he struck Delores as a cross between a deer and a Persian cat that walked on its hind legs—and she couldn't recognize him, even though she and Jan had lived in this neighborhood for several months. She felt fortunate that kya identified one another by scent, not name; she could fake it by greeting him with a loud sniff, a deep, appreciative sampling of his scent.

"Good to scent you, too, Del," the kya said as he padded across the grass to them. He went to the lawn mower, knelt by it and sniffed it in curiosity. Just like a cat, Delores thought in amusement. The kya had an exquisite sense of smell, and she sometimes thought the kya made more use of their noses than their eyes—or their brains.

The kya finished his inspection and stood up. "Clever, you humans," he mused. "Having heard of these, I've always wondered what they looked like—but I didn't know your food processors were so big. May I?" he added, as he reached for the clippings in the open catcher.

"Go ahead, Zark," Jan said in Wideplain. Delores knew that she and Jan spoke the language poorly; the kya preferred to start their sentences with participial phrases. "Have all you want; we can't eat it."

"No? Pity." Zark took a handful of lawn clippings, sniffed them and ate them. His eyes gleamed. "Delicious! Seeing you spend so much time tending the lawn, I thought it a waste of energy, but tasting it, I have to say you're a terrific cook, Jan."

"Thanks," Jan said. She and Delores sat down on the grass with Zark. "What's the latest?"

He sniffed happily. "You haven't caught the scent? With the theater coming around tonight, the whole neighborhood's trotting over to the park in a while."

"What's playing?" Jan asked, with an enthusiasm Delores couldn't share. Kya movies all struck her as art-house material: dull and incomprehensible.

Zark's muzzle twitched. "Not having scented the titles, I couldn't say. But newsreels being on the schedule, the evening won't be a waste even if the films turn out to be stinkers." Then he sniffed thoughtfully as he glanced at the heap of lawn clippings. "Could I take some of that? I always get hungry during movies, and there's never anything to eat."

"Take all you want," Jan said.

"I'm not sure I want to go," Delores said, after Zark sauntered off with a double handful of grass cuttings. "I've got office work waiting—"

"Let it," Jan said. "How often do you get out? You're turning into a hermit like Nyquist."

Delores gave in. A short while later they were on their way to the neighborhood park, where a projectionist had set up a portable screen and movie projector. Jan, who had brought along a large bag of lawn clippings, mingled with the audience as they milled on the park grass. Delores, who was interested in antique technologies, chatted with the projectionist about human and kya styles of entertainment.

"A *tee'yatr*?" the kya repeated to Delores, as he fussed with his equipment. His muzzle twitched in curiosity. "Saying that, you mean something like a building, don't you?"

"Yes, with a roof and all that," Delores said, glancing up at the sky. It was overcast, and promised to rain. "Not only could you keep dry, but it's always dark inside a theater. You could show films during the day and make more money."

"Something to that," the kya said with a thoughtful sniff. "But, buildings being big and heavy, how could I carry one around with me?"

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"You wouldn't," Delores said. "You'd stay in one place."

The projectionist let out a baffled gronk. "Why would I want to do *that*?"

"Never mind," Delores said in resignation. The kya had developed cities and buildings out of necessity, but the notion of settling down in one spot didn't sit well with their migratory instincts. Territoriality, a xenologist had once told her, was a form of behavior which the kya displayed only in the violent wards of their mental institutions.

Seeing that the projectionist was ready to start the show, Delores moved off to join Jan, who stood at the edge of the crowd. "Standing room only," Jan commented, nodding at the kya. In the darkness, the crouching, huddled audience looked more like a herd of deer than anything else. They kept jostling around, seemingly uneasy at staying on one spot for more than a moment. Delores noted that Jan seemed a little more relaxed than before. A night out seemed to be just what she needed.

Static roared from the portable speakers and a black-and-white movie flickered on the screen: a newsreel. It started with a map that showed the area held by the invaders, with arrows to show the movement of refugees away from the occupied zone. Shots of refugees followed that, while a narrator described the overgovernment's efforts to ease their problems. The unseen kya's words made it sound as though the invasion barely counted as a nuisance.

The next scenes showed that the kya took the invasion seriously. The audience snuffled in approval as they saw a squad of soldiers patrol the edge of the invasion zone, single-shot rifles in their hands. The camera panned to a kya whose cloak bore the symbols of a high-ranking military man—or woman, Delores mused; she still hadn't figured out how to tell the difference between kya sexes.

Male or female, the leader spoke with obvious confidence. "*We now have the—*" he made a disgusted exhaling sound, the Wideplain equivalent of a name for the invaders "*—totally surrounded. Doing that, they can see the edge of our herd, and that we're prepared to defend ourselves.*"

"*Saying that, you expect to win,*" a reporter's voice said from off-camera.

"*Correct,*" the leader said. "*Being more determined than the—*" disgusted exhalation "*—are, we've got this war run into the ground.*"

"I hope the invaders understand that," Delores muttered. The kya saw warfare as a symbolic thing, in which two herds faced one another and postured until one side or the other backed down. It was nothing like the human view of war—or, Delores suspected, like the invaders' view.

She glanced up at Jan. The flickering light of the screen showed that Jan's frustration had returned in full force.

"You didn't tell me?" The bed creaked as Jan rose up on one elbow. The bright morning sunlight that came through the bedroom window seemed to make her dark face burn with anger. "*Help is coming, and you didn't tell me?*"

"That's part of my job," Delores said. She wanted to kick herself. Of all the secrets she could have let slip, why this one? "Look, when we tied the knot I told you I couldn't discuss everything I did, especially because—"

"—because I'm a reporter, and there's a war on," Jan said in chagrin. "I know. Loose lips sink ships. I like old movies, too." She sat up, pulling away from Delores. "But you could have told me. Damn it, we're *married*."

Delores felt hurt by her angry tone. "I thought it would be easier for you."

"Not having to sit on a secret I can't report?" Jan was silent for a moment. Then she lay down again. "Yeah, maybe you're right. I'm some reporter," she went on, as she stared up at the ceiling. "There's a war going on and the people back home should know about it. Instead I'm covering bagdrag games."

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Delores nodded. Seeing a kya newsreel reporter cover the war—and doing a bad job of it—must have been the last straw. "I thought you liked your job."

"I do, but I like the kya more."

"Well, so do I," Delores said.

"No, you just tolerate them," Jan said. "You spend all your time in the embassy or in the house. You're hardly ever around them—"

"I see plenty of them at the embassy!" Delores protested. "And I like them."

"Name five of our neighbors," Jan persisted. Delores said nothing. "Did you know that Zark is a biologist at Vrekle University? How many kids are there in the neighborhood? Who's the alpha?"

"The what?" Delores asked blankly.

"The dominant male in the local herd," Jan said. "The chief bull. God, Del, it's how they reproduce. They all have sex, but when a lady's fertile she gravitates toward the most impressive fellow in the neighborhood. Most of the kids you see around here have the same father."

That left Delores baffled. "I thought—it *looks* like they have families—"

"Just like us? Sure, they live in houses, with one fellow living with one lady. But that's only partly love. It's also herd behavior, a childless fellow helping to take care of the herd's progeny. You didn't know?"

"No," Delores admitted. "You know I spend most of my time dealing with humans—mostly ones who want to cheat the kya on a business deal. I'm too busy protecting them to get to know them."

"How can you protect them when you don't understand them?" Jan asked. When Delores said nothing Jan pressed on. "I'm around the kya a lot more than you are. I talk to them. I go to parties after games, and meet the players' friends and families. I want the people back home to know what they're like. And you've got to admire the way they're bearing up under the invasion. There's no panic, no disorder, no profiteers ripping off the refugees. They *deserve* to have their story told."

She's going native, Delores thought. The UN had warned her against that when they had trained her. Her job was to look out for Earth's interests, not Kya's. That was a basic fact of all diplomacy . . . and it was putting a strain on her marriage. "I'll talk to the ambassador again," Delores said. "Now that help's coming they won't have a reason to keep a lid on everything. They're going to need someone to report on the action."

"You think so?" Jan asked.

Delores managed a laugh. "Heroic Earthlings battling evil alien invaders? The politicians are going to demand coverage." That thought mollified Jan, who gave Delores a kiss.

With peace restored in her home, Delores realized she still had a problem. Ambassador Nyquist would never violate any orders his superiors gave him. He wasn't the sort of man who played games to advance his own career; she knew he was dedicated to the UN. Which was a fine thing, she thought, if she could turn it to Jan's advantage. That was the problem that Delores mulled over as she rode her electric scooter to the embassy that morning.

When she got there she was surprised to find hundreds of kya packing the street in front of the embassy. She parked her scooter against the embassy's perimeter wall and pushed her way through them to the main gate. "Del!" one said as she reached the gate.

Delores stopped and looked up at the kya who had called her name. His voice sounded familiar. "Zark?" she guessed.

He gave her a polite sniff that was almost lost in the gronking, rumbling noises of the crowd. "Having heard rumors about some good news, I got here early. Good to be at the front of the herd, isn't it? Being here, can you tell us anything about the briefing?"

"The ambassador will do that," Delores said. The gate recognized her and let her in, and she hurried across the compound to the main building.

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The ambassador sat behind his desk, and he looked annoyed as Delores entered his office. "I might have guessed," Nyquist said in resignation. "Tell one of them, and you tell the whole damned herd. We must have every scientist and politician in the province out there."

Delores nodded. "The question is, what do we tell them now?"

"The truth," he said, and grimaced. "Or at least, as much of it as they can handle; Earth has authorized that. I'll brief them now. Tell the auditorium to get itself on-line, and bring them in."

"Yes, sir. There's something else, sir."

He looked up at her. "What?"

"Well, we're going to need favorable news coverage of events," Delores said. "The UN will want people to see how well they've handled things here—"

"—and you know the perfect reporter for the job," Nyquist concluded.

"It wouldn't hurt to get things set up in advance," Delores said.

"It's against regulations," he muttered. Then he scowled as though struck by an unpleasant thought. "But it's also sensible. I'll discuss this with Earth. Now get moving."

The auditorium was a large chamber which served many functions—banquet hall, entertainment center, reception area, even gymnasium—and Delores spent her time directing its computers to set it up for several hundred kya guests. Microbots reworked the floor and walls, creating seats to accommodate kya posteriors and a podium for their human hosts. As the kya crowded into the auditorium they ignored the seats at first, and Delores watched them jostle one another for positions close to the podium. There was nothing rough or violent about the way they behaved, but it made Delores wonder about the sort of people the kya chose for leaders.

Nyquist seemed to entertain similar thoughts. He looked at the crowd after he joined Delores on the podium, and he spoke into her ear. "Did you know they're all male?"

"Kya are sexist?" That surprised her. "I thought—"

"—they were more sophisticated than that?" Nyquist chuckled. "It's herd psychology. The alpha males run everything. They're the ones doing all the pushing, to establish who's the top alpha."

"I thought they were just being rude."

"More like childish. They're lucky we're here to save them." The ambassador shook his head in amusement and stepped up to the microphone. "Earth has authorized me to make this announcement," he said, and as his voice boomed through the auditorium the kya stopped jostling one another and looked up to him. "The first phase of help has been received here. Our staff is now assessing the situation, and when we decide upon the most effective means of attack we will remove the invaders from your planet. We anticipate applying our military force in five days."

Delores tried not to look puzzled. She wanted to ask Nyquist what he meant, but one of the kya in the front row saved her the embarrassment of interrupting her boss. "Talking, you say 'help has been received,'" the kya said. "Having checked, I know that no human ships have landed here since the invasion."

"Help didn't come on a ship," Nyquist said. "That would be a very sloppy way to make war, wouldn't it? All the help we need has been sent by tachyon radio in the form of computer blueprints and programs. Our microbot assemblers will take this data and use it to build weapons here."

Sniffing sounds came from the crowd, which made Delores wonder if they were trying to judge that claim by its odor. "Doing this, will you supply the weapons to our soldiers?" another kya asked.

"Our weapons don't need soldiers," Nyquist said. "They're fully automated. They'll destroy the enemy in whatever way seems least likely to harm your

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planet and people. We'll probably use a biological agent, one tailored to attack only the invaders. Our genetic-engineering techniques are more than good enough to do that. We could change their genetic code slightly, so that their offspring become non-viable or lose the urge to reproduce—well, there are many things we can try."

"Planning this, do you know enough about the—" disgusted exhalation "—to consider your weapons reliable against them?" the same kya asked.

"Yes," Nyquist said. "Our scientists have made detailed observations of the invaders. Now that is all I am authorized to tell you at this time." He turned toward the podium's steps.

"Saying this, you've overlooked a vital question," a kya gronked out from the rear of the auditorium. "Planning this operation, is it wise to destroy the—" disgusted exhalation "—rather than negotiate with them?"

Nyquist looked at him and exhaled in a kya gesture of contempt, as if trying to clear the kya's odor from his nostrils. Then Nyquist spoke as if to a backward child. "No one has managed to communicate with the enemy. They've ignored our signals. Their only interest appears to be in conquering your planet—*all* of it," he finished.

"Saying this, can you prove it?" the kya said. Delores realized it was Zark. "Observing your scientists, we know that none have entered the occupied area—"

"It's too dangerous," Nyquist said. "We can't risk losing any of our scientists on some wild venture. Besides, our remote-sensing gear makes that unnecessary."

Zark started to say something, but his words were lost in angry gronks and exhalations from the crowd. Nyquist left the podium and exited the auditorium through its rear door, leaving Delores with the crowd. Most of the kya were already on their feet, and the noise in the auditorium grew as they argued with one another. Delores climbed off the podium and pushed her way through the crowd to where Zark stood.

He greeted her with a bemused sniff. "Talking, I seem to have sneezed out a real stink, haven't I?" he asked. "Being part of the embassy, can you tell me anything about the war plans, or haven't you been authorized to say anything?"

"I haven't even been *told* anything," she admitted.

Another kya broke in on them. "Saying that, it can only be because there's nothing important *to* tell you," he said. "Followers needing to know where they're going, your leader would have told you everything important, true?"

Delores thought Zark looked pained by that. "Humans being alien, we can't always expect them to act like us," he said.

"Sneeze on that!" another kya said. "And sneeze on your theories, Zark! With the—" disgusted exhalation "—acting as they do, we can be sure they've invaded for no reason other than taking all this world!"

"Saying that, you're only describing one possible theory," Zark insisted. "Acting as they do, the—" disgusted exhalation "—might not be part of an invasion, but something quite different. A survey party, a diplomatic delegation, tourists, land-sculpting artists for all I know. That being possible, we should move cautiously until we have more facts."

More kya joined them, jostling Delores as they crowded around her and Zark. "Behaving as they do, they can only be invaders," one of the newcomers said. "Annoying the ambassador, you risk losing our only chance of survival."

"Yes!" another kya said. "Coming here, it is the invaders' obligation to explain their actions!"

Herd animals, Delores thought in annoyance. She might not be an expert, but she could see that they were trying to overwhelm Zark and bring him into line with everyone else. Hell of a way to run a world, she thought—but even as

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the arguments turned into an incoherent roar of angry voices she could see that Zark refused to change his mind.

Jan chuckled when Delores described the scene to her that evening. "Our neighbor, the mad scientist," she said, twirling her fork in her spaghetti.

"I wouldn't call Zark mad," Delores said. "Just pissed off. He thinks he's right, but no one will listen to him."

"Including that meatball of an ambassador?" Jan speared one of the meatballs on her plate, emphasizing her opinion of Nyquist. "You know we're not defending this planet just to be nice to the kya."

"Meaning what?" Delores said.

"Meaning that military help is expensive," Jan said. "Even when all we're doing is using cheap robots, it still costs money. Somebody has to design the robots, program them, plan how to use them—" She shook her head. "I wonder if they're looking for a chance to test weapons here."

"Maybe the UN is doing this because it's *right*," Delores said.

Jan reached out and patted her hand. "Del, you'd do something because it's right, but these are politicians. If their motives are good, why aren't they telling *you* everything? And there are human scientists on Kya. Why weren't any of *them* at the briefing? Why wasn't *I* invited?"

"It was staged in a hurry," Del said. "We were going to have it a few days from now, but when all those kya showed up the ambassador had to reschedule it to keep rumors from spreading."

"That doesn't explain why no humans were invited to the original conference," Jan said. "Or why Nyquist didn't wait an hour or so to bring some of our people in. People who could have given the kya some real answers. Something's wrong here."

Delores didn't want to believe that, and she fought down an impulse to argue. "Don't let Nyquist hear you say anything like that," she said.

"Credit me with *some* sense," Jan said. She took a bite of spaghetti, then got up to answer a knock at the door. It was Zark, who came in at her invitation. "What brings you here?" Jan asked him.

"Having a plan, I need a favor," he said. The twitching of his muzzle made Delores think he felt nervous. "Having whiffed enough gripes from my colleagues, I'm putting together an expedition over the invasion zone."

"An 'expedition'?" Delores asked.

"Perfectly safe," Zark said. He followed them into the house's front room, where he awkwardly seated himself on the arm of a chair. "Flying high, several planes have passed over the zone unharmed."

"And a lot more have vanished," Jan said as she sat on the couch with Delores.

"Vanishing as they did, they got careless," Zark said. "Going there, we're taking along the best observation gear we can find—cameras, binoculars, and so on. Doing this, our main problem is communication. Our airborne radios, being unreliable and short-ranged, I wanted to borrow one of your radiotelephones to send our reports home."

In case he doesn't come back, Delores thought. "Why are you doing this?" she asked.

"Going, I want to learn about these aliens," he said. "With everyone planning to destroy them, I think everyone is making a mistake. Behaving as they do, the—" disgusted exhalation "—could be other things besides invaders."

"He's got a point, Del," Jan said. "What if the aliens are here as a diplomatic team, like you?"

"In which case destroying them would be a blunder," Delores said. She leaned against Jan, but the physical comfort she took from that did nothing to ease the uncertainty she felt. "But maybe we won't destroy them. We're bound to have reconnaissance robots in

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those plans Earth sent us; nobody attacks without studying the enemy first. If there's a good reason *not* to fight, we'll find it."

"Hearing that, I hope you're right," Zark said. His muzzle had been twitching all along; now he shuddered. "But . . . having doubts . . . still—" He shuddered again, and Del wondered if he was going to get sick.

"Zark," Jan said, "all we ate for dinner was vegetables and processed chemicals. It only *smells* like real meat." Even so she got up off the couch and opened the living room window, letting in fresh air.

Zark let his breath out. "Knowing that you're aliens, I still have trouble adapting to that. That being so, it's another reason for me to go on this expedition, rather than rely on your reports."

Jan nodded. "You might notice something our scientists missed."

"And you need a telephone," Delores said. "We can do that."

"We can do better than that," Jan said. "I'm going with you."

"I think you married a crazy woman," Nyquist said, when Delores reported to him in his office the next morning. He looked at her over his cup of tea. "Can't you talk her out of this?"

Delores managed a weak smile. "This is *Jan*, sir. I can't get her to reboot her sanity software."

"I know." He sipped his tea, then put the cup aside. "And I know her type. Stubborn and eager for a good story. She thinks there's something suspicious going on here, doesn't she? What with all the secrecy?"

Delores hesitated; she didn't want to voice all of Jan's suspicions . . . especially as those suspicions had raised doubts of her own. "She thinks we're taking this chance to test new weapons here."

"She'd be a fool if she didn't think that," Nyquist said. "Earth hasn't fought a major war in twenty years, so all our tested military technologies are obsolete. And who knows what we're facing with these aliens? Our observations say they're small creatures, but we have no details. It's better to try out weapons and tactics here than on Earth. It sounds cynical, but it's the truth."

Delores felt relieved to hear that. "It's a good reason for secrecy," she said.

"Pragmatism never plays well with the voters," Nyquist said, "even when they benefit from it." He turned his head as the office door opened. Saito, the computer specialist, poked his head through the doorway. "What is it?" Nyquist asked him.

"I've finished the preliminary work with the software Earth sent, sir," the young man said. "All of the blueprints run in the assemblers."

"Good," Nyquist said. "I want you to build a set of those robot spies, the ones we discussed last night."

"Yes, sir." Saito went away.

Nyquist returned his attention to Delores. "I talked with Earth about your suggestion last night," he said. "They've approved it."

"Thank you, sir."

"Not so fast. First, Jan can record anything she wants, but she can't broadcast anything without my approval. Second, I expect *you* to keep her under control. Make sure she doesn't 'accidentally' broadcast something to Earth, or editorialize about our motives."

"Yes, sir."

"Good." He picked up his tea cup and took a sip. "You want to accompany her, don't you?"

Delores nodded. "If Jan's going—"

"You want to be with her. Very well. I can justify that as part of your duties as operations officer."

"Thank you sir. I think," she added honestly. She didn't like the idea of flying over the invasion zone.

"My pleasure," Nyquist said. "As long as you're going, I want you to take some of Saito's robots. Just don't let this Zark fellow get you into trouble." He picked up a paper on his desk and looked at it.

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"Zark has a reputation as a maverick, which isn't a good thing among herd creatures. Too impulsive to become an alpha, too contrary to settle down as a follower, too impressed with himself to admit when he's wrong—doesn't even have a mate." Nyquist set the paper aside and looked at her. "Don't let him drag you into trouble. Now get going."

Delores left Nyquist's office and went to the embassy's factory room. Saito was at work there, monitoring an assembler as it constructed a robot. "Are the robots ready?" she asked.

Saito answered without looking away from his terminal. "Uh-huh. That box in the corner."

"Okay." Delores picked up the small carrying case and started to open it. "How do I—Jesus!" She jumped back and dropped it, and stepped back even further as a dozen tarantulas and scorpions fell to the floor. She grabbed an instruction manual from a table and prepared to swat the nearest creature.

"Hey, careful!" Saito said. He took the case and started picking up the creatures. "They're harmless."

Delores felt foolish and angry at the same time. Large, poisonous bugs did not appear on her list of favorite things. "They're robots?" she asked.

"Spy. uh, spybots." Saito seemed as nervous as Delores felt; she guessed she wasn't the only one who felt squeamish around crawly things. "The instructions said they used models like these for reconnaissance and point-sabotage in the Sand War. Visual surveillance, IR, radio, audio, I forget what else. They don't blend in here, but maybe the invaders won't realize that."

Delores forced herself to look at one of the scorpions, which waved its pincers and stinger at her. The overly-realistic creature made her queasy, but she could see that its head wore a cluster of tiny lenses and antennae. "How do I use these things?" she asked.

"Easy," Saito said. "You're flying over the invasion zone. They're light enough to fall a dozen klicks without breaking, so all you do is open the box and toss them out of the plane."

By noon the only thing Delores had tossed out of the plane was her breakfast. Zark had rented a wood-and-fabric contraption with two wings, one motor and no safety systems. Its pilot, a kya named Aur, sat in the front of the cabin and guided her plane by pushing and pulling rods, pedals and knobs. It worked, but Delores found that the vehicle swayed through the air as if seeking out every downdraft and crosswind in the sky. The quivering of the engine only added to the lurching and shuddering of her stomach—

Cut it out, she told herself as she squeezed her eyes shut.

Jan, who sat next to her in the cramped cabin, leaned over and spoke into her ear. "You okay?"

"Never better," Delores muttered. She glanced around the cabin, which sported several empty seats. "Bet I know why Zark's colleagues chickened out," she said.

Jan shook her head. "Kya don't get airsick. They stayed home because, uh . . ."

Zark looked over his shoulder and snorted in laughter. "Because being sensible, they don't want my insane scent to rub off on them." Zark snorted again and pointed out a window.

Delores looked and saw the edge of the invasion zone two kilometers below the plane. The border was marked by a crude fence of barbed wire and a path beaten out by kya military patrols. Rich green grass covered the rolling land on the kya side of the border. On the other side—

A belt of dead ground marked out the edge of the invasion zone. Beyond that belt, Delores could see patches of rust-colored vegetation here and there, gradually thickening towards the interior of the zone. She thought she saw things moving around down there, but she knew it had to be her imagination. The

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invaders were too small to see from this height.

Jan and Zark went to work as they crossed over the invasion zone. Jan opened a window and poked her camera out through it, while the kya scientist peered through binoculars, jotted notes on a paper pad and fussed with his own camera—a box which used a lens to record a few images on silver-nitrate film. Up front, Aur worked her controls and kept the plane more-or-less on a steady course as its engine roared away. Far below, the alien vegetation became thicker, and Delores felt certain she saw movement on the ground.

Time to drop the spybots, she told herself. She had dreaded this moment. Not only did the spybots look like scorpions and tarantulas, but Saito had told her that they carried real venom in their stingers, for use against enemy personnel. Delores hoped the machines knew she was on their side. She twisted around and reached for the carrying case, which she had placed between the rear of her seat and the cabin's aft bulkhead.

Pop—pk-pk-pk-pk-pk-pk—hssssss . . .

"Aw, *snort*," the pilot said as the engine sputtered and died. Air whistled around guy wires as the plane glided along. Delores watched Aur fuss with her controls, but the engine stayed dead. At last the pilot looked over her shoulder and spoke to her passengers. "What with the engine belching up like this, we're going to land."

"Here?" Delores asked.

Aur snuffled in dry amusement. "Not knowing how to land on clouds, I can tell you it's here or nothing. The ground looking smooth up ahead, there won't be a problem."

Sure, no problem, Delores thought as the plane sped toward the ground. The machine made a good glider, but she wondered if there was any point in making a safe landing. The aliens might do anything to them.

Aur worked her controls with obvious expertise, but the plane still touched down with a jolt that made its wooden struts creak. It bounced wildly across the uneven land as it rolled to a halt. As soon as the plane stopped, the pilot swung open the glass bubble atop her cockpit, grabbed a tool kit and climbed out.

Delores took the case and exited the plane through its rear hatch. As she stepped into the hot noonday sun she looked around. The plane had come to a rest on a patch of bare dirt, but much of the nearby ground was covered with high, rust-colored grass that was broken by clumps of red and brown bushes with spiky leaves. She saw a river in the distance, and a jumbled hill of boulders about a kilometer away, but there was nothing nearby. The silence seemed more unsettling than any noise.

Then Delores heard scraping, skittering sounds at her feet. She let out a yelp as she looked down. There was a ragged hole in the bottom of the case, and the spybots were dropping out through it. They raced away from the plane, and as Delores tossed aside the case they vanished into the rusty grass.

"Weird," Jan said, as she checked her pocket computer. "The map says there's a tin mine in the area."

"You're sure?" Delores asked her. "I don't see anything."

"Yeah." Jan pointed to the hill. "That's dirt and rubble from the mine. The invaders have demolished everything else."

Zark joined them, binoculars in his hands. "Looking around, I can't even find a road," he said. "Roads being convenient, and being well-placed for surface transport, you'd expect the—" disgusted exhalation "—to at least keep them."

"Maybe they don't need roads," Jan suggested. "Maybe their vehicles use antigravity, or maybe they have teleportation."

"I wish *we* had that," Delores said. She wiped away sweat from her face.

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The day had seemed cool while the plane was in flight, but down on the ground it was unpleasantly hot. She walked to the front of the plane and got in the machine's shadow. She got out her phone card and called the embassy. Nothing happened, even though the embassy's phone system was supposed to have unlimited range. She decided that the aliens were jamming communications, and she put her phone back in her hip pocket.

Aur had opened the engine cowling and was hammering away at the mass of iron beneath the panels. As Delores watched, the pilot stopped working and stepped back from the machine. "Swamp gas," she grumbled in disgust.

"What?" Delores asked.

Aur gestured at the engine. "Having clean edges, it looks like the fuel line has been cut," she said. "The mnog must have shot us with something." She wrinkled her nose. "Gasoline smelling this bad, I wish we could use alcohol in airplanes."

Delores got up and looked into the cluttered engine compartment. The air carried the strong odor of gasoline, and she saw fuel drip from a severed copper tube . . . and, in the firewall behind the engine, she saw a ragged hole. Like the tube, the hole's edges looked freshly cut. Just like the hole in the case, she thought uneasily. The spybots were designed to commit sabotage, when the opportunity arose; she wondered if Saito had forgot to remove that talent from their programming. "Can you fix it?" Delores asked, as Jan joined her.

"Having no choice, I can," Aur said.

"Better hurry," Jan said in a strained voice. "We have company."

Delores turned around and saw movement in the rust-red grass. Creatures the size and shape of corn cobs began to emerge from the grass's edge, dozens at first, then hundreds, then thousands. "Like a swarm of ants," Jan said as she fixed her camera on them.

More like bees, Delores thought. The creatures sported black and yellow bands ringing their lengths, faceted eyes, and what looked like stingers in their tails. The comparison ended there. Pincers waved at the corners of their mouths, bristles covered their eight legs, and many of them carried small silver objects on their backs.

Light flashed and the plane shuddered as part of a wing vanished. Aur let out an angry gronk and threw a wrench at them, and it crushed one of the aliens as it smashed into the creature. Aur should have brought along a hardware store, Delores thought as another section of the plane vanished. One wrench wasn't enough.

"Anyone wanting to stay alive, move around!" Zark said. "Move, move, move!"

When Delores hesitated, Aur grabbed her arm and pulled her along. Must be herd instinct, Delores thought: run like hell when there's trouble. It might have worked when the kya's ancestors were fleeing carnivores, but it accomplished nothing now; the aliens surrounded the airplane, forcing Delores and the others to run in a circle. Light flashed again and again, and chunks of the flying machine vanished.

The aliens formed a thick ring around the plane, but as Delores jogged along she saw that the land beyond them was open. The only problem would be in reaching that ground—maybe. "How much fuel is in the tank?" she panted to Aur.

"Lots," the pilot said. "Why?"

There was no time to answer. Delores broke away from Aur, and peeled off her shirt as she went to the engine. She reached inside, grabbed the broken fuel pipe and twisted it down. Fuel gushed out, and she held her shirt under it while Jan shouted at her to keep moving.

Right, she thought, as more sections of airplane vanished. She moved away from it as part of the landing gear disintegrated, and she hoped her shirt had sopped up enough fuel. "Come on!" she

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shouted, and moved towards the aliens, holding the soaked shirt in front of her. For a second she was afraid the aliens would swarm over her, or shoot her, but as the gas-soaked shirt neared them they scurried away, repelled by the stink of petroleum products.

The gasoline forced a gap in the alien swarm, and the others followed Delores through the opening. Then they were past the aliens, and Delores turned back to look at the aliens as they swarmed around the plane. There was something orderly about the way they moved. It puzzled her; the bugs *should* have scrambled to get away from the gas.

Jan came up next to her. "Good thinking," she said.

"Thanks," Delores said as she stared at the aliens. She took Jan's camera from her and began to record the scene. The aliens looked as if they were performing a complex dance. Something about that nagged at her, as though she were seeing something she should have recognized.

Jan seemed ready to explode. "You little lunatic, what are you doing?" she shouted as one of the airplane's wings collapsed. "Come on!"

"Just a minute," Delores said. She spotted Zark through the viewfinder and recorded him as he knelt at the edge of the swarm, picked up something and stuffed it into a rucksack.

Jan swore, grabbed Delores and slung her over her shoulder. Delores kept recording the swarm while Jan dashed away with her. She pushed the camera's zoom function, and then was annoyed when a greasy fireball covered the scene. She looked up from the viewfinder and saw that the plane had exploded in flame, wiping out the aliens.

Delores looked around. There were swarms of aliens scattered across the ground. Jan and the kya were running toward a low, rough hill. Despite her burden Jan kept a good pace, and Delores thought they reached the base of the hill in record time. Jan set Delores on her feet, and the four crash survivors started climbing the hill. Its top was cluttered with large boulders, and they sat in the shade of one.

Zark set the rucksack at his feet. "Landing here, we're the first people to scent the aliens this well," he said. "And, scenting what we have, it all suggests the mnog are insects."

"'Mnog'?" Delores repeated.

Aur sniffed in agreement. "Seeing them, you have to agree that mnog is a more appropriate name for them than—" disgusted exhalation "—true?"

"No, I don't have to agree," Delores said. "What does the word mean?"

"It's this word children use," Zark said. "*Mnog'rkstvo* is what you call it when they all go running around in the same direction, like our visitors do. Children shorten it to 'mnog' because it's easier to pronounce, and—"

"A children's word," Delores said in disbelief. Despite all the destruction Zark didn't seem to take the invaders seriously.

"I can't pronounce it, either," Jan said. "Anyway, what makes you think they're insects?"

"Aside from their chitinous odor?" Zark snuffled in amusement. "Observing the mnog, I noted their faceted eyes. Using faceted eyes, they can't have complex neural systems as do higher forms of life; complex brains demand excellent eyes. Throwing that wrench at them, Aur showed that they have poor reflexes, poor eyesight, perhaps a poor visual image of the world."

"Is that why you made us run in circles?" Delores asked. "You figured they couldn't see a moving target well enough to shoot it?"

Zark sniffed in agreement. "Being lucky, I made a good guess," he said.

Delores nodded at that, although she realized he was being modest. Under the circumstances, his idea had amounted to a stroke of genius. "What do we do next?" she asked.

"That being a good question, I think we should discuss it," Aur said.

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"What's to discuss?" Delores asked. "We want to get out of here alive."

Jan nodded. "Which means outsmarting the mnog. Zark, you're the only scientist we have. You'd better take over." Aur gave a sniff of agreement, and Delores nodded. "Looks like you're the leader of the herd," Jan said.

"Saying that, you're quite generous," Zark said. He held onto the rucksack as he stood up and looked around. "The ground being bad here, we should be safe. Mine and smelting wastes being mildly toxic, the mnog should ignore this ground."

Delores didn't like the sound of that. "How toxic is 'mildly' toxic?" she asked.

"Years of rain having scrubbed this ground, it's just bad enough to keep plants from growing," Zark said. "Being here, we may as well observe the mnog in action. Then, the mnog being what logic says they are, we wait until it gets dark."

"If your logic is right," Delores said. She gestured at the rucksack. "What's in the bag?"

"Mnog," he said, and opened it. Delores glanced inside, and looked away at the sight of several dead insects. "The gas having killed these, I thought it would be a good idea to run home with some specimens."

Once the sun went down the hot, clear day turned into a cold, clear night. Delores spent her time huddled with Jan, and wished she'd used something other than her shirt as mnog-repellent. Jan had given her the shirt off her back, but while it had shielded her from the worst of the sun it did little now to keep her warm.

Zark had taken Jan's camera almost at once, and spent the day taping the mnog. The creatures stayed clear of the hill, but the camera's zoom and image-enhancement functions let the scientist see all he wanted. The mnog roamed the landscape in great swarms, sometimes merging together and separating again, sometimes moving large distances as though migrating. They ate the vegetation like locusts, but Delores noted that by sundown the rusty plant life had begun to sprout again in the stripped paths.

When the sun set Jan showed Zark how to use the camera's infrared vision, and he continued his work. He gronked quietly to himself, but after a while he gave up and joined Aur and the two humans. "Observing the mnog, I've noted an impossibility about them," he said. "Having such small heads and bodies, how can they be intelligent?"

"Maybe they have a hive mind," Delores said. She had meant that as sarcasm, but that failed almost at once. Zark wasn't exactly a primitive . . . and she didn't have a good answer for his question.

Zark didn't know that. "'Hive mind'?" he repeated.

"It's an old idea," Jan told him. "Instead of having a brain that's made up of many cells inside one body, you have a mind where many bodies each act like cells in a brain."

"Hearing that, I wonder how it would work?" Zark mused. "Radio? Nerve links between the bodies? Having studied hives, I can't see how these individuals could form a mind. Interesting."

"What's interesting is how we'll get out of here," Delores said. The last of the day's heat had fled into the clear night sky, and she was shivering. That took her mind off being hungry, thirsty and sunburned, but she didn't count it as an improvement.

"The night being cold, we could start now," Zark said. He picked up the rucksack with the dead mnog and slung it over his shoulder. "Watching the mnog on infrared, I've seen the swarms slow down, suggesting they're cold-blooded. All of us being faster, I think we can elude any swarm that notices us."

Delores hoped that he was right. "Where do we go?" she asked, as Zark started to lead them down the side of the hill.

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"Having no other choice, the river," Zark said. "Heading south as it does, it will lead us to edge of mnog territory. Getting that far, we walk into the water as deep as we can—" Aur let out a horrified gronk at that "—and try to get out unobserved. Inert objects having floated out of this area in the river, it seems the mnog have limits on what they attack."

"Makes sense," Jan said. "The mnog need to keep things out, not in."

Delores thought the reasoning was bad, but she had no time or energy to spare for that. The night was so dark that her surroundings were reduced to vague, dark blurs. Zark led the way, using the viewfinder and IR setting of Jan's camera for night vision—and using his nose. Several times Delores heard him stop and sniff the air, and then change directions when he caught the odor of a mnog swarm. True to Zark's word, none of the aliens bothered them.

There was plenty of evidence of the alien presence, however. Alien plants grew everywhere, and several times they passed large masses of a gelatinous substance which covered the ground. "Eggs," Zark said, when he paused to examine one mass. "Small eggs. The eggs being this small, the mnog must hatch underdeveloped."

Jan bent to peer at the clutch of eggs. "A whole lot of eggs. The queen must be huge."

"We haven't seen any big bugs," Delores said. She kept her voice down.

"And who says they've got to have a queen?"

"That's true," Zark answered. "And, sniffing around, I've noted that the eggs have different scents, as though layed by many different females. That being so, it implies the mnog have no queen, no central hierarchy."

"Which would make the mnog harder to exterminate," Jan said.

"Worse," Aur said. "The eggs being so numerous, the mnog population must be ready to explode. They'll take more area soon."

"Which means we'd better warn everyone," Delores said. "Let's go."

The going became easier when they reached the river; its banks were sandy and free of obstructions, and the faster pace allowed Delores to warm up. The trouble was that a faster pace would bring them to the border that much sooner, and Delores thought the mnog would be more observant—and quicker on the draw—at the border.

Dawn was glowing on the horizon when they saw the bare ground that marked the border. "Seeing that, it's time to get in the water," Zark said, and handed the camera and rucksack to Delores. "Being human, you can do that thing where you move around while floating in the water, can't you?"

Delores felt blank. "You mean '*swimming*'?" She had to use the English word; she realized she didn't know its Wideplain equivalent. "Yes. So can Jan."

"Good. Going in, I want everyone to stay about fifty vults behind me, in case I'm wrong about the mnog ignoring us." Zark turned and waded into the river. Delores waited, then went in with Jan and Aur when the kya pilot decided Zark had gone far enough ahead of them. Delores decided that fifty vults equaled a hundred meters or so.

The water felt warmer than the early dawn air, and Delores found that the current helped move her along. She held the camera and canvas sack above her head as she tried to stay shoulder-deep in the water. Starlight glinted on the water, making her feel like a target.

Suddenly Zark foundered, flailed his arms and went under. Delores saw Jan spring forward at once, cross the water with the same speed she had shown in the Olympics, and vanish below the surface. She emerged with Zark a few seconds later, and kept his head up while she pulled him into shallower water. Zark wheezed and gasped for breath, then went back into the lead.

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The sun was well above the horizon by the time they reached friendly territory. They slogged out of the river, and Delores sat on the bank with Jan while Zark and Aur squeezed water out of their thick pelts. Delores set the rucksack aside; she had the queasy feeling that the mnog in it were not dead.

Jan eyed Zark. "He's got guts," she said quietly.

"Uh-huh," Delores said. "Going first to make sure the mnog wouldn't shoot us—"

"Not that," Jan said as she slipped an arm around Delores' shoulders. "Getting in the water like that, and then going on after he almost drowned. Kya can't swim. That's why they don't have a word for it."

"I didn't think about that." Delores looked at Zark. "I keep expecting him to act like a wimp. Is he really an alpha?"

Jan shook her head. "No. It's a social thing with kya, and most of them think he's a nut case; he doesn't even have a mate. He could turn into an alpha if a lot of their females started taking him seriously, but that won't happen."

"Why the females?" Delores asked.

"Reproduction," Jan said. "They try to choose the best possible father for their offspring, which means picking the most impressive fellow around. Which means smart, clever and sensible. That spills over into their politics—the leaders are all alphas, but they can't keep that status if they don't impress the females with their brains."

"I see," Delores said.

"I . . . see," Jan repeated. "Del, you make that sound like it means something special."

"I was just thinking about something the ambassador said," Delores told her. He had made it sound as though the kya were driven purely by instinct, which no longer seemed true. For that matter, Delores thought, Nyquist's low opinion of Zark didn't match the kya's actions . . . and the trouble with the Saito's spybots kept nagging at her. She knew she was going to have a lot of questions for Nyquist when she got home.

A kya patrol found them not long after they emerged from the water. Zark spoke with them, and got directions to their camp. Once there he persuaded the base captain to give his group a truck, and shortly thereafter Jan was driving the vehicle down an uneven dirt road which—Zark claimed—led to the observation post set up by a team of human scientists.

Delores hoped he was right; she hated to think that the dull, jolting ride over this road might go for nothing. She sat alone in the back of the truck, which offered her shade from the scorching sun. Her exposed skin was badly sunburned, and the pain left her too dispirited to care about much. She wished Jan had left the driving to Zark, but Jan had insisted on riding up front with Zark and Aur.

A sliding panel separated the rear of the truck from the cab. Eventually the panel slid open and Zark spoke through it. "We're there," he said, and gave a thoughtful sniff. "Luck being with us, the observation post is there, too."

The truck stopped, and Delores climbed out and looked around. "There" was a cluster of small, glassy buildings, constructed by microbots out of the silicates in the soil. The UN camp stood behind a hill which screened it from the occupation zone, and a cluster of instruments atop the grassy hill seemed to watch nervously for the first sign of an alien assault.

A set of antennae pointed to the opposite horizon, and the main research base far beyond it. The sight of the antenna farm reminded Delores that she should contact Ambassador Nyquist and let him know that she was all right. When she started to pull her phone out of her hip pocket, however, she paused and slid it back. She realized that Jan's suspicions about Nyquist didn't seem as far-fetched as she had thought . . . and

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letting Nyquist know they had survived didn't seem like a good idea just yet.

The scientific team was led by an aging Chinese woman with iron-gray hair. She introduced herself as Dr. Feng. "We heard about your crash," Feng said as she led Delores and the others into the observation post's main building. "The UN embassy reported all of you as dead."

"Saying that, they were premature," Zark said easily. He had taken the rucksack, and he now handed it to Feng. "Being there, we brought back some dead mnog."

"'Mnog'?" Feng asked.

"It's what they call the invaders," Delores said. "And we have some pictures of them—"

Feng didn't seem to hear her. The scientist went to the building's door and shouted something in Mandarin, and at once the rest of her team began to crowd into the room. Zark took Jan's camera and handed it to one of the humans.

Jan spoke quietly to Delores. "Let's do something about your sunburn."

Delores didn't argue. They left the main building for one of the smaller structures, which looked like a small dormitory. It was, and they found a first-aid kit in its office. Jan activated it and let it work on Delores. "You should feel better in a few minutes," she said, and sat in the chair next to hers.

"Right." The process was supposed to be painless, but she still felt discomfort as the kit infected her with a genetically-engineered virus. She started to sweat as the virus attacked specific parts of her body, stimulating the healing and growth processes in her skin. It was better than enduring the burns and blisters, but she still felt as though she were coming down with a case of the flu.

And Jan was looking at her. "You have something you want to say, don't you?" Delores asked.

Jan nodded. "Aur noticed something odd about the engine."

"As in a cut fuel line, when there was no way anyone could have cut it?" Delores asked.

"Right. And I looked at that carrying case."

"Which had a robot-size hole snipped in its base," Delores said. "A hole just like the one in the engine compartment."

"Just the right size for one of those scorpion-type robots," Jan said. "Somebody didn't want us to come back from this expedition."

Delores scowled. "Murder isn't the ambassador's style."

"But following orders is," Jan said. She took out a handkerchief and wiped the sweat from Delores' face. "Maybe someone told him to let us go on this expedition, and to have us take along those spybots. That same someone could have programmed the spybots to sabotage us. Nyquist might not have known," she added.

"Maybe," Delores said. She didn't like the idea, but there were a lot of things to dislike here. "But why?"

"To keep something secret," Jan suggested. "Del, something fishy is going on here. Did you notice how excited Feng acted when Zark said he had some dead mnog? She's obviously never seen one up close, which means no human scientist has gone in there—"

"The UN won't authorize it," Delores said. "It's too risky."

"I don't think either of us believe that," Jan said.

"I don't know what to believe anymore," Delores said. She looked at her forearm and saw that her sunburn had faded back to her normal fair coloring. She felt a bit feverish from the treatment, but it was nothing she couldn't endure. "There has to be a simple explanation for everything—failures to communicate, a programming defect in one of Saito's spybots—"

"Maybe." Jan stood, and took her hand to help her out of her seat. "Let's get something to eat, and find a place to sleep. Maybe Zark and Feng will have

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figured out something by the time we wake up."

That hope proved correct. They spent the day sleeping in the dorm, and Delores woke late in the afternoon. She left Jan asleep in the bed, got a sandwich from the kitchen robot, and went off in search of the science team.

They were hard at work in the central building. Delores walked down the building's central corridor and found Zark and Feng in the biology lab, where they probed into a dissected mnog. "It's a lot like a terrestrial insect, or its Kya equivalent," Feng told Delores, after Delores asked her if they were making any progress. The elderly woman poked a set of electrodes into the creature as she spoke. "The internal organs and biochemistry are different, of course, but the differences don't have anyone pulling out her hair."

Zark idly brushed at his furry shoulder. "And it's poikilothermic, as I thought," he said.

"'Porko . . .'" Delores shook her head. "You mean cold-blooded?"

Zark sniffed in agreement. "Being so, it's sensitive to cold, just like native insects, and Terran as well. Hearing this, you can scent why I expected them to become dormant at night. Looking for a way to fight the mnog, I would say we need nothing more than a lot of snow to stop them."

"Sounds like a plan," Delores said. She looked at the opened-up insect, which lay on its back in the dissecting tray, and then looked away. "How often do you get blizzards in this part of Kya? Once every, what, ten million years or so?"

"About that," Zark agreed. "That being the case, my plan *does* have a few minor details to work out."

"We're not going to stop the mnog that way," Feng said. She looked at the dissected mnog as though she were a general contemplating an enemy. "Kya doesn't have enough of an axial tilt to create appreciable seasons. As near as anyone can tell, only the polar regions are cool enough to keep the mnog out."

Delores saw the implications. "So if we can't stop them, pretty soon they'll push everyone into a couple of small areas."

"Doing that, it could get crowded," Zark agreed.

"It's more likely they'll destroy all of Kya's native life," Feng said. "A stable ecology needs a large area. Right now you could maintain the two separate systems on Kya, but that won't work if you confine one of them to a small area. But look at this." She gestured at the mnog in the dissecting tray. Delores steeled herself and looked at its innards. "See these bundles? They're nerve trunks, one connected to each leg. This central bundle is the brain."

A woozy feeling made Delores look away from the dead creature, but she realized there was something odd about that. "Shouldn't that bundle be in the head?"

"Senses being important, the brain *should* be in the head," Zark said. His muzzle twitched as though something annoyed him, bu. Delores heard only scientific curiosity in his voice. "Staying close to the nose and eyes, the brain gets messages faster that way. Being set up like this, however, the legs seem more important to the mnog brain. Dissecting a leg, we've found that each cilia attaches to a single neuron."

"Like they sense the world through touch?" Delores asked.

"Or communicate through it," Feng suggested. "Bees tell one another where to find pollen through a type of dance."

Zark sniffed thoughtfully. "Talking with Delores earlier, she suggested the mnog might have a hive mind. Considering what she said, and what we've seen here, I wonder if thought-impulses aren't transmitted by touching the legs. With the individual mnog having such small brains, yet showing intelligence, we need *some* mechanism to explain their behavior."

"I don't think that's it," Feng said. She gave Delores a reproachful look, as if to

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chide her for foisting such a preposterous idea on an unsuspecting alien. Delores felt her face redden with embarrassment as she recalled that she *had* made the suggestion for that reason. "There's no way that the mnog could form direct synaptic connections by touching their legs."

"Maybe they don't have to," Delores said. Something had nagged at her ever since she had first noticed the mnog's dance. There was something precise and mechanical about that dance—yes, that was it; it reminded her of something she had once seen in a museum. "Maybe it's a mechanical process, like the cams and wheels inside an old adding machine."

"Or an evolutionary development of something like this bee-dance you mentioned," Zark mused. "Communicating, each mnog acts like a cell in a brain, or a small cluster of specialized nerves."

"No," Feng said in annoyance. "I don't believe it. It would make their thought processes too slow! Especially as the swarms can only form a two-dimensional array on the ground. Our brains have a three-dimensional structure. That lets the neurons form a greater number of connections. The sort of hive-mind you propose couldn't do that."

Zark sniffed, then shrugged. "Needing a theory to cover the facts, I'm ready to follow a better explanation."

"*I* think they're a terraformation tool," Feng said. "Somebody else created the mnog to pave the way for them. Once the mnog have finished their work—destroying the old environment and establishing a new ecology—their creators will move in."

"I don't know," Delores said. "If the mnog are just tools, shouldn't they move out of an area once they're finished with it, and start working on something else? We saw them swarming all over the place, eating everything in sight—and the vegetation grows back awful fast. Almost as if it was their ideal food."

"Coincidence," Feng said, and shook her head. "Look, this is just an outpost. We should get our samples and data back to our base, where we can do some *real* research."

Zark seemed about to reply, but he paused and took several quick sniffs that made his muzzle twitch. "Do you scent that?"

"Scent what?" Feng asked.

Zark went to the lab door, opened it and took a deep breath. "Mnog," he muttered. "The scent being strong, it's as though—" He inhaled loudly, then turned around. "We have to evacuate."

He sounds awful bossy, Delores thought before she understood the urgency in his voice. "The mnog are coming?" she asked.

"Yes," Zark said. "Spread the word, then get to the truck."

Delores hurried to the dorm, where she woke Jan. "Figures," Jan said, after Delores hurriedly explained the situation to her. "All those eggs we saw—it figures they wouldn't take long to hatch. I wonder how much turf the mnog'll take this time?"

"Probably a lot," Delores said. She picked up the camera while Jan climbed into a set of borrowed coveralls. "The question is, how long before they get here?"

"Not long," Jan said. "And the mnog will get here first. I don't think they'll ignore us this time."

Delores couldn't argue with that. She followed Jan out to the borrowed kya truck, where the base's personnel were scurrying to load equipment, samples and records into a motley assortment of vehicles. Zark, Aur and Feng were doing the same with the truck. "We have to abandon a lot," Feng said, while Delores turned on the camera and recorded events. "There's no time, not enough transport—you're certain this thing will run?" she asked Aur.

"Quite certain," Aur assured her. "Driving it herself, Jan has shown a definite flair for it. You might wish to observe

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her techniques while Zark and I ride in the back."

And take the opportunity to examine some human technology, Delores thought. She shrugged off that notion. "How much time have we got?" she asked Zark.

He sniffed the air. "None," he said. "The mnog being close, it's time to stampede out of here."

Delores got into the truck's cab; Feng scrambled in through the other door. Jan sat in the center, at the controls, and started the engine. As the truck lurched away from the base Delores leaned out the window with the camera. The truck seemed to be the last vehicle out; as she looked through the viewfinder she saw nothing but empty buildings and scattered rubbish.

As she watched, a building flashed into white light and disappeared. She spotted a silver glint on the horizon and zoomed in on it, and that showed her a swarm of mnog as they demolished an instrument tower. The devices on their backs might have been tiny, but they were powerful. Delores pulled back into the cab. "Punch it!" she told Jan.

The truck surged ahead. Delores glanced out the window and saw more glints of light on the horizon. She couldn't tell how fast the mnog were moving; she only hoped the truck was faster.

"We're faster," Jan said when Delores asked about that. "What I want to know is, how far will the mnog come? We may not have enough fuel to outrun them."

"Zark had some ideas about that," Feng said. "Half of the mnog are female, and each lays a hundred eggs in a clutch, so when they hatch their population will increase by a factor of fifty."

"So they'll need fifty times as much land," Delores said. "Which means they'll move their border out, what, two thousand clicks?"

"No," Feng said. "They have to extend the area's radius by the square root of fifty. Call it four hundred kilometers."

Jan shook her head at that. "We don't have enough alcohol to do four hundred clicks. We'll have to refill the tank. Seen any filling stations anywhere?"

"Not yet," Delores said. She decided to ask Zark for suggestions. She twisted around in her seat, opened the panel to the rear—then blushed and shut the panel. "Something wrong?" Jan asked.

"No," Delores said in embarrassment. "They're, uh, just clearing up Zark's complexion."

Feng looked puzzled. "You can't say the kya have a complexion. The fur covers their entire facial . . . oh."

Jan grinned, took a hand off the truck's tiller and patted Delores' knee. "Romance in the face of danger. You have to love it."

"Not while you're driving!" Delores said as the truck lurched over a massive bump in the dirt road.

Kya's blazing white sun had set by the time the truck reached the UN's main research base. It was a good deal larger than the abandoned observation post, but Delores thought it looked just as starkly utilitarian as the post. Its one saving grace was that it was over a hundred kilometers from the edge of the newly-expanded occupied zone.

The UN scientists crowded around the truck as Jan parked it in front of the main building, and Delores noticed that a dozen or so kya stood among them. Several of them greeted Zark as he climbed out of the back of the truck, and Delores thought they seemed less hostile to him than the scientists she had seen at the embassy briefing. She understood that change when she saw Zark remove a container with dead mnog from the back of the truck; the kya scientists had to be eager for their first look at the invaders.

"It's more than that," Jan said, when Delores voiced her thoughts. Jan spoke as she recorded the scene with her camera. "A kya scientist found those specimens, which is more than *our* scientists have done."

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Delores nodded. "And they're so proud of that, they don't care if it was Zark."

"You might say that."

"I just did." Delores took Jan by the elbow and steered her away from the crowd. "Let's find a computer someplace."

"What have you got in mind?"

"Let's say that the mnog have a hive mind," Delores said, as they walked toward one of the base's buildings. "Let's say that the individuals act like circuit chips in an old computer, and that they communicate by dancing. Let's say that we have some good pictures of them communicating." She tapped Jan's camera.

"And let's say we have no idea what they're communicating about," Jan said.

"Not now, we don't," Delores said. "But if they communicate by physical means, what will you bet that a computer can find a pattern?"

"Not much," Jan said. "Unless you know something I don't?"

"I might," Delores said. "Let's find the administration building. I need to contact the embassy."

The administration building proved to be a large dome at the center of the base. Delores found an empty office, and Jan stood behind her as Delores sat down at the office's computer terminal. "What are you looking for?" Jan asked, as Delores fussed with the computer.

"A cryptology program." Delores spoke as she studied the directories on the computer display. She touched her fingertip to the display, picking out the programs she wanted. "We have a lot of them."

"To spy on the kya?"

"You didn't hear that from me," Delores said while the computer downloaded the software to her terminal. "But we also adapted them for linguistics. Translating an alien language has similarities to breaking a code. You look for patterns and meanings, and try to change them into something you can understand."

Jan looked dubious. "Human codes are based on human languages, with human referents. Can the computer make sense of whatever the mnog use for a language?"

"It's worth a try," Delores said. "We live in the same universe, so we must have certain things in common. And I have a hunch that the mnog that swarmed around the plane were talking about it. If I'm right, it'll give the computer a starting point. If I'm wrong—huh?"

The display went blank. Saito appeared in the display, and the young computer specialist looked shocked to see Delores. "You—we heard you were dead!" he said.

"You heard wrong," Jan said, before Delores could answer. "The plane's engine conked out and we had to walk home. Didn't your spybots keep an eye on us?"

"No, we programmed them to scatter after you released them, to, uh, look for any hive-queens. Not that we found any. I'm glad you're all fine," he went on hastily. "It's just a shock, I mean, we held a memorial service this morning."

"I'm sorry we missed it," Delores said. "I hope the ambassador said something nice about us?"

"Yes—look, why didn't you call us earlier?" Saito asked.

"We didn't have time," Delores said. "Anyway, we're fine, and Jan has a report on the invaders. We'll send it in so Mr. Nyquist can clear it for broadcast. Talk to you later." You son of a bitch, she thought as she broke the connection. She hoped Saito hadn't seen the cold anger she felt. She didn't want to believe that someone had wanted everyone on the plane killed, but she couldn't ignore the evidence.

Jan was staring at the display. "Whatever happened, he was in on it," she said.

"I know," Delores said. "The spybots can be remotely controlled. So why

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didn't he use them to help us, or keep an eye on us?" She held up a hand before Jan could speak. "Because we were supposed to disappear without a trace, and this way—"

"—the spybots wouldn't accidentally record a 'trace,'" Jan concluded. "But why would the UN want to keep anyone from learning about the mnog?"

"Let's find out," Delores said. She took the camera from Jan and linked it to the terminal's data reader, which copied the images in the camera's memory. Then Delores looked at the cryptology programs, and tried to decide how to fit the images into their format. The programmers had written their software to cover every imaginable form of communication, including physical gestures—but as Jan had suspected, their imaginations hadn't stretched quite far enough to cover the mnog.

Delores thought she could make up for the difference, although proving it took much of the night. Jan brought her sandwiches and coffee while she fussed over the terminal and wished she knew more about computers. She slowly learned that the cryptology programs had more flexibility than she could have expected, and that with a few nudges the software could examine the videos and look for information. The only problem was finding enough pictures of the mnog that were clear enough to show the swarm's activities.

At last the computer started to process the videos, and Delores pushed her chair back from the terminal. "Binary," she grumbled, while Jan stood behind her and massaged her shoulders. "I kept looking for something complicated, but the damned bugs tap their legs together in binary code. You can't get any simpler than that."

"Sometimes simple is good," Jan said. "It's reliable. It's easier to process with a computer. Hey, we're getting something."

"Finally." Delores sat up straight as an image filled the screen. It was distorted, but recognizable. "That's Aur's airplane."

"And a good picture, too," Jan said. "The mnog must form an image by putting together what each bug sees. But what are all those little arrows?" Her eyes widened as she leaned closer to the image. "Air flow. Lift and thrust vectors. Del, they aren't just looking at the plane, they're *thinking* about how it flies. That means—"

"—that a scientist like Zark should see this," Delores concluded. "Let's get him in here."

Jan looked her over. "What have you got in mind?"

"Just a hunch." Delores wished she could put her feelings into words. "Have you noticed how Zark has acted since the crash?"

"He's been a little bossy," Jan said. "Why?"

"I wonder if he's turning into an alpha," Delores said. "The boy's just had three girls play follow-the-leader with him, and he's impressed Feng—not to mention Aur. All that female attention must have an effect on him."

Jan shook her head. "It could be a start, but it would take a lot more than that to keep the ball rolling."

"Such as making some scientific discoveries about the mnog?" Delores tapped the display with a fingernail. "There's a good one right here. He can prove that the mnog have a hive-mind. They aren't a terraformation tool, like Feng said; they're the actual terraformers."

"Why do you want to build him up?" Jan asked.

"Because we need an alpha on our side," Delores said. "Jan, Nyquist planned on us getting killed. That's why he announced we were dead. And that briefing he gave at the embassy—he acted more like an alpha than a diplomat."

"You mean he's trying to dupe the kya into something."

"And whatever it is, the bastard nearly killed us over it. That sounds like a good reason to screw up his plans." De-

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lores hesitated. That wasn't the attitude of a good career bureaucrat. On the other hand, her boss had tried to kill her. It was time to look for a new career.

Delores woke up in the back of a large van. After a few seconds of disorientation she realized it was speeding down a road. She recalled climbing into it last night, and thinking she would never get any rest. It surprised her that she could have slept here, but the ride was smoother than she had expected, the folded tarp more comfortable. She sat up and saw that Aur was asleep nearby, resting in a crouch atop a small sleeping pad.

Zark was there as well, and he greeted Delores with a cheerful sniff. "With Jan driving like she does, we'll reach your embassy soon," he said. He sidled across the decking and crouched alongside her. "Thinking about the mnog, I have an idea about communicating with them. Could you build some spybots to resemble the mnog?"

"I suppose so," Delores said. "What have you got planned?"

"Knowing how the mnog communicate, we could use the robots to mediate with the swarm. Moving up to the edge of the swarm, the robots could brush legs with the creatures."

"Would that work?" Delores wondered. "Maybe you can tap out a binary message that way, but would the mnog understand it?"

"Having considered that point, I couldn't say," Zark admitted. "Being a hive-mind, they may not have the concept of communicating with others—they may not even realize other minds *can* exist. But wouldn't it be fascinating to learn how the mnog view themselves and the universe?" He sniffed thoughtfully, then sneezed on the faint burned-alcohol scent of the truck's exhaust. "Humans being a lot like us, I doubt you're even a twelfth as alien as the mnog."

He sounds like he's bored with us, Delores thought. She smiled, showing enough teeth to remind Zark that humans weren't vegetarians. "At least we'll be around longer than the mnog."

"That destruction thing?" Zark asked. "Having a chance to talk with the mnog, is there a need to destroy them?"

"They've invaded your planet."

"Not the *whole* planet," Zark said placidly. "Talking with them, perhaps we can negotiate an arrangement." He looked at her and inhaled slowly, as if trying to sample her thoughts with her scent. "Having listened to the ambassador, I wonder why he seems so obsessed with this war-fighting notion. War being wasteful, it may be an evolutionary aberration only we and humans practice."

He sounds so optimistic, Delores thought. "You'd better get more practice, or you won't do much more evolving, aberrant or otherwise."

"The war going as it has, we're doing quite nicely," Zark said. "With their herd pushing against ours, they're fighting *our* way, which we can handle. Once we find a way to push back firmly, we'll have this settled. Doing that, we'll have no need for violence."

"Yeah, right." Delores felt exasperated. As she rested her back against the van's wall she wondered if his attitude meant he was taking on the alpha role. If so, she wondered how well he could handle it. He didn't have much time for on-the-job training. Delores shook her head and told herself to stick to her own problems. Staying alive looked to be the biggest of them. Nyquist might try to kill her and Jan again. He must have acted on orders from the UN, but what reason could they have had? And what could she do about that?

She was still mulling that over when the van rolled to a halt outside the UN embassy's main gate. As the engine quit Delores heard the low gronking of kya, and when she climbed out of the back of the van she saw that the vehicle was surrounded by reporters. Must be a big

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news day, she thought as she saw their film-cameras and radio microphones. The local press always swarmed around the embassy when something happened.

The mob around the van gronked questions at Zark as he and Aur got out of the van. Delores only caught fragments of their words as they asked Zark about the crash, the mnog, his findings. She wished she could tell what the crowd thought of Zark. The scientist seemed sure of himself, as if he expected their full attention, but he had behaved that way during the briefing.

Jan appeared at her side. "He's having the time of his life. Everyone's taking him seriously now."

"Alpha City, here he comes," Delores said. She looked at the embassy gate. "Jan, can you run interference for me while I get to the factory room?"

"Interference?" Jan looked puzzled for a second, then nodded as she caught the hint. "Sure. I've always wanted to interview Nyquist. Maybe I can get some dirt on him."

Or put him six feet under the dirt, Delores thought as the embassy gate opened itself for them. A pair of security men stood inside the gate, and Delores gave them a casual nod as she and Jan stepped through. She felt anything but casual. Nyquist had tried to kill her; she wondered if the security forces knew about that.

Probably not, she decided. Murder was always a dangerous game, and the more people you brought into a conspiracy, the more risk you had of something going wrong—or of somebody listening to their conscience. She hoped she was right, but she still felt uneasy as she and Jan walked across the compound and entered the main building. Jan headed for Nyquist's office, while Delores went to the factory room.

Saito was there, working at the computer console. The young man looked tired and punchy, as if he had lived the past few days on coffee and no sleep. He turned around and his face went pale as he saw her. Guilty, all right, Delores thought. "Okay, mister, *explain*," she said angrily.

He stood up on rubbery knees. "Explain—explain what?"

"How you're going to feel about going on trial for attempted murder." She walked up to him and jabbed a finger into his chest. He was bigger than her, but he looked intimidated. "Think I can't guess what you tried? And do you think Nyquist will save your weaselly ass?"

Saito looked frantic. "He said—the ambassador *told* me—"

"—that you have diplomatic immunity? Wrong." Her smile showed enough teeth to frighten a kya. "You can use that to get away with trying to kill Zark and Aur—but Jan and I aren't kya. *We* can take you into court on Earth—"

"—and have your case thrown out," Nyquist said as he entered the factory room. "You may ignore her threats, Mr. Saito."

Delores glared at Nyquist. "Where's Jan?"

"Security escorted her off the grounds," Nyquist said. "She may be your spouse, but that doesn't give her the right to harass me. What do you think you're going to accomplish here, Delores? Blackmail me into something?"

That was the idea, Delores thought. It still might work; Jan had bought her just enough time to wring a confession of sorts from Saito—and the young computer specialist still looked apprehensive. "Zark doesn't want to exterminate the mnog," she said.

"You say that as though it means something." Nyquist leaned against the door frame, looking for all the world as though he were in full control. "Mnog. A word from kiddie-talk, of all things. This great native scientist thinks he can communicate with the invaders, doesn't he?"

"He's found a way to do it," Delores said. She knew she had to keep on top of the situation. "I want you to modify

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some spybots to resemble the mnog. You *can* do that, can't you?" she asked Saito.

The young man nodded. "It'll take a few hours, but—"

"—but we won't do that," Nyquist told Saito. "That isn't in our orders."

"But killing four innocent people is," Delores said.

"Yes," Nyquist said bluntly. "Zark and your spouse are a threat to the UN's plans. Zark might persuade the other kya not to fight the invaders, and there goes the war, *and* the entire population of this planet. As for Jan, she's determined to get a story. *Her* story."

"That's her job," Delores said. She shook her head in bewilderment. "Damn it, the UN can use all the friendly publicity it can get! Why not let her report?"

"Because we have to manage the news carefully," Nyquist said. "This war places us in a lose-lose situation. The kya are popular on Earth. If we can't save them, it's our fault for losing the war—and it makes everyone wonder how well we can protect Earth from the invaders. But when we defeat the aliens—you realize we'll have to kill all of them? No prisoners, no truce?"

"Do we?" Delores asked.

"That's the decision of our best military minds," Nyquist said. "The invaders didn't come all this way to lose a war. So we have to wipe out the invaders and their colony—which opens the UN to charges of genocide."

Delores saw the point. "And either way, the UN isn't going to bring a crisis on itself."

"Not when it might endanger the defense of Earth," he said. "Suppose these aliens invade while we're playing blame-games? I'm sorry you got caught in the middle, but that's how it is. And now I have to straighten out this mess," he went on. He scowled as though thinking, then turned to Saito. "*Can* you modify those spybot blueprints to make them resemble the invaders?"

The young man looked startled. "Uh—yes, sir."

"Get to work on it." Nyquist looked to Delores. "We may as well let Zark try to talk to the invaders. It can't hurt, and it might prove useful. I'll give Zark one week to get results."

"'One week,'" Delores repeated. She wondered why Nyquist was giving in; it made her suspicious. "By the way, I'm taking a leave of absence."

Nyquist barely looked surprised. "Now? In the middle of the war?"

Delores ignored that. "I've accumulated several months of leave time, and you can manage without me." Or did you think I'd come back from the grave to run the front desk? she wondered.

Nyquist shrugged. "I suppose we *will* manage. No one is irreplaceable."

The week passed without results. Saito's nanotech factory produced several hundred mnog-like robots, along with robotic aircraft which could carry them into the invasion zone. A control unit was delivered to Zark's home, along with a computer designed to decode messages and allow communications. "Not that the mnog are communicating," Zark told Delores at the end of the week.

"Any idea what the problem is?" Delores asked.

Zark sniffed thoughtfully. "Being a hive-mind, they don't seem to understand the notion of other minds."

"Which means they don't know how to communicate with other minds."

"Indeed," Zark said. "We can decipher *how* they think—images and symbols, so on—but *what* they think about is another matter. Get a whiff of that," he said, and gestured at the computer's video display. It showed a small patch of land in the invasion zone, where a line of robots had moved up to the edge of a mnog swarm. For a moment Delores watched the creatures rub legs with one another, but then her distaste for creatures with too many legs made her look away.

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Zark misread the expression on her face. "Trying various things, I've made *some* progress. Sensing our messages, the swarm seems aware of something unusual. The sub-swarm we see here is contemplating a notion I translate as 'disturbed unity.' But, their thought-processes depending upon touch and physical movements, and upon sub-swarms handling small chunks of ideas, their hive-mind works very slowly. Being slow, the mnog might require many years to develop the notion of alien beings."

"I see." Delores grimaced at that. "If the hive-mind is so damned slow, how could it have developed interstellar flight?"

"Landing here, they obviously did," Aur said. "Perhaps the mnog have existed unchanged for millions of years. Having that much time, a hive-mind could tolerate slowness, even when individuals die and are replaced."

"Well, *we* can't tolerate slowness," Delores said. She glanced at her watch. "Nyquist is going to call me soon. You can bet he'll tell us you're out of time."

"It *has* been a week," Zark said glumly. "Talking with him, tell him it's only a matter of time before I get better results."

Delores promised to give Nyquist that message. She left Zark's home and walked down the street to her home. Jan was in town, doing some kya-in-the-street interviews. Doing something useful, she thought. Delores's leave of absence kept her away from Nyquist, and while that may have kept her life-insurance premiums down, it left her feeling useless.

Nyquist called at the local equivalent of five o'clock. "Zark's time is up," he said when Delores answered the phone.

"He already knows," Delores said. "He wants more time."

"Scientists," Nyquist muttered. "Tell him he can keep trying, but we have to start our operations now. Dr. Feng says that the mnog will start their next reproductive cycle in a few more weeks. She calculates that they'll occupy over twenty million square kilometers by the end of the cycle. That's an area roughly the size of Africa—and the cycle after *that* will fill the entire planet."

"I know," Delores said. "What are we going to do to the mnog now?"

"We're going to start with a suite of plagues," Nyquist said. "Most of the viruses we release will kill the mnog outright. As for the survivors, the ones with natural immunity, we've developed other viruses that will transform their DNA. That won't harm the victims, unfortunately, but their offspring will be too defective to live."

"It sounds effective," Delores said, and shivered. She told herself that the mnog had brought this on themselves by invading Kya—but genocide still made her uneasy.

"Talking that way, your ambassador doesn't sound too optimistic," Zark said that night. He paced the tiled floor of his home's common room while Delores and Jan sat side-by-side on a pile of rolled-up sleeping mats. "Reality being what it is, I suppose he has a point—but I can still get results." He spoke English for their benefit.

"I'm sure you can," Delores said. Zark sounded almost casually arrogant, which she supposed was a good thing in an alpha. He probably didn't need to have his ego built up any more, but she saw no harm in doing a little extra work. "It's going to impress Earth when a kya makes contact with the mnog."

Zark sniffed in agreement, then looked sly. "Talking as you do, I appreciate the boost, Del," he said. "Alpha behavior being new to me, I may as well admit I'm slinging it."

"You mean 'winging it,'" Jan said.

"Maybe a little of both," Delores said. She looked up as Aur come out of the kitchen with a mug of what smelled like boiled lawn-clippings. On her way to give it to Zark, Aur casually touched things

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here and there: the door jamb, a small table, a window sill, Zark's elbow. Putting her scent on everything, Delores noted, marking her property. Zark might have become an alpha, but it was clear that Aur thought of him as *her* alpha. Zark seemed to accept that as a matter of course.

Delores shivered slightly as the night breeze blew through the open window. With their delicate sense of smell, the kya needed lots of fresh air. Their thick fur let them endure that air when it got cold, but Delores found herself leaning against Jan for warmth.

Zark was talking about his plans to communicate with the mnog when Delores heard a knock at the door. Aur answered it and Saito stepped into the house. "What are you doing here?" Delores asked in surprise.

"We need to talk," the young man said. He glanced around, clearly uncomfortable at being in the presence of four people he had almost murdered. "The ambassador—everything he told you about the war was a lie."

Delores wondered why she didn't feel surprised. "What do you mean?"

"The UN has decided not to fight the invaders." Saito began pacing back and forth. "I pulled some decoded messages from the computer system. The UN wants to avoid a war. And all those viruses we developed, he told me we wouldn't release them."

Delores started to say something, but Jan shushed her while Zark spoke. "I get the scent. Not knowing how powerful the mnog are, your UN fears provoking them. Doing that, they're protecting the human herd from possible destruction. Selfish, but sensible."

"You don't get it, do you?" Saito said in exasperation. He reached into his jacket and pulled out some folded-up printouts which he handed to Zark. "Tomorrow we're going to announce that we've already infected the mnog. Later, we'll announce that the diseases didn't work. Who can prove that we didn't release the bugs?"

"What's the point in that?" Jan asked.

"The UN doesn't *want* to fight," Saito said. "They think they can do better dealing with the invaders than with the kya."

"Why is that?" Jan asked, while Zark looked at the printouts.

"Business." Saito almost spat the word. "The kya are primitive. We can't sell them much modern equipment because they can't use it, much less afford it. And what do they have that we don't already have? Perfumes, sports, trinkets? All we get from the kya are novelty items."

"But the mnog are different," Jan said. "They already have interstellar travel, death rays—who knows what else? They could make a great market. Or they could be so advanced that anything we learn from them could revolutionize our economy. Either way—"

"—Nyquist lied to me," Delores said. Despite the cold breeze through the open window she felt her face grow hot with anger. "*Again*."

"He's consistent, just like any slime," Jan said. Delores saw her eye Saito in obvious suspicion, and Delores knew she suspected the young man of more treachery. "Why did Nyquist *really* want us killed?" Jan demanded.

"I don't know," Saito said. "He told me the same things he told Delores, but it doesn't hold up."

"You've got to have *some* idea," Jan said.

"No, he doesn't," Delores said grudgingly. She would never like Saito, but she could see that he wanted to make amends for his actions. "If Nyquist had sent him, he would have prepped the kid with a good story. Con men always cover all the angles. I think we'll have to wring the truth out of Nyquist."

"Hearing all this, I think I can guess the truth," Zark said. "Killing Jan, the UN could keep her from reporting the facts. Killing me, your scientists would be discouraged from attempting to copy my expedition into mnog territory. Being witnesses, Del and Aur were in the

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way. That Nyquist is a clever little sneeze."

"Very clever," Aur said. "Giving you that equipment, he lets you discover how to communicate with the mnog. With you doing all the hard work, he can later steal it for Earth's use."

"Nyquist didn't expect Zark to find anything," Delores said. "I think he did this to appear cooperative, so we wouldn't make trouble."

"And so we wouldn't suspect more treachery," Zark said. He gave the printouts a thoughtful sniff, then handed them to Delores. "This mess being what it is, it could put a strain on our relations with Earth. How do we prevent that?"

"Do we want to?" Aur asked. She stood by the door, which she had left open. Delores saw her fur ruffle lightly in the cold breeze. The pilot knew that Nyquist had ordered her plane sabotaged, but while she had taken that news calmly Delores realized it had made a deep impression in her. "Doing this, is it a good idea to have anything to do with Earth?"

"I don't know," Delores admitted. "But I think the real question is how do we keep your people from getting wiped out?"

"We can start by getting some real news to Earth," Jan said. "That might force the UN to keep its word. If I put together a report, can we get it to Earth without the UN censoring it?"

"I think so," Saito told her.

"Doing that, what happens next?" Aur asked. "Not wishing to exterminate the mnog, we can't let the UN 'save' us that way."

"Saying that, you're quite right, scented one," Zark said. "Mass murder being evil, we can't allow it."

"But what if it's the only way to save Kya?" Jan asked. "Look, these mnog came from somewhere else. Wiping out this one colony won't hurt the rest of species on their home planet."

"Doing that, we would still eliminate all the mnog here," Aur said. "The mnog forming a hive-mind, wouldn't that be like murdering a unique individual?"

While the others argued over what to do, Delores sat quietly and read Saito's papers. The papers backed up his story, and gave more details. Early in the war the mnog had shot down a UN starship. Telemetry from the ship suggested that the attack was a misunderstanding. The ship's drive had radiated a tremendous amount of energy, but the aliens had not fired on it until its maneuvers had placed it on a collision course with Kya; it seemed the aliens had mistaken it for a dangerous natural object.

A mistake, Delores thought. As she read on she discovered that the UN found the attack made a convenient cover story. Declaring that a state of war existed allowed them to keep other ships from visiting Kya, and it let them censor the news from Kya. It would prove impossible to hide the extinction of another sentient species, but proper handling of the news would minimize the political impact on Earth, and allow terrestrial corporations to start doing business with the aliens.

Delores dropped the papers on the floor. She had worked for the UN for seven years; she had volunteered for this assignment, even though Kya was a hardship post. It still seemed a worthwhile thing to do with her life. Nothing like idealism to make an idiot of you, she thought, and where did that leave you? Following orders that would turn your stomach when you lost faith in them.

Get a grip on yourself, she thought. The UN's leaders were doing something evil. That didn't mean she had done anything wrong. But what in hell was she supposed to do now?

A gust of breeze pushed the papers across the floor. She reached for them, and shivered in the cold. *That* would have solved the problem; the mnog couldn't function when it got too cold. Too bad it wasn't always this cold on Kya, but you couldn't change the whole planet.

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But what if you could change the mnog?

Delores looked around as though remembering the other people in the room. "Saito," she said. "Did the UN really send us plans for a genetic-engineering virus?"

He looked startled. "Uh, yes. We don't plan to fight, but if the aliens are a problem—or the kya—"

"We're ready for them," Delores said. "Can we use it to make just one change in the mnog? Something that won't kill them, but will leave them with unhealthy offspring?"

Saito looked thoughtful, then nodded after a moment. "The virus comes from basic medical stock, and Feng cracked the aliens' genetic code. It *should* be a simple plug-in problem. What have you got in mind?"

"Modify the mnog," Delores said. "Slow their metabolism and make them more sensitive to the cold, so they can only live near the equator."

Zark took a long, slow breath, as if sampling the idea's scent. "Elegant," he said at last. "Doing that, we won't have to worry about miscommunicating with the mnog, or having them ignore our wishes."

"If it works," Saito said. "And what if they retaliate when they catch us tampering with them? They could wipe us out."

"They'll do that if we don't try anything," Delores said. "This way gives us a chance."

"Good point," Zark said. "As they do not yet know that aliens exist, this change could seem like a natural event to them. The question is, can we sneak this past Nyquist?"

"I think so," Delores said. "Let's get to the embassy and—"

She had started to stand; Jan grabbed her and pulled her back down. "Think, Del. The *embassy*? Where Nyquist can get another shot at us?"

"I don't think he'll try anything there," Delores said. "There are too many witnesses. He tried to kill us where nobody could see it. Besides . . ." She glanced at the kya. "We have to try."

Jan hesitated, then nodded.

As they entered the embassy and headed for the factory room Delores realized she had felt safer in the invasion zone. She had Jan, Zark and Saito with her, but there was no security in numbers. Nyquist probably wouldn't take any action against them at the embassy—but she saw a large gap between "probably" and "definitely."

That gap became evident when Delores saw Nyquist and two armed security officers standing outside the door to the embassy's factory room. "Cripes," Jan muttered from behind her, "It's Ming the Merciless and his henchmen."

Nyquist missed her comment. "Delores," he said, giving her a cordial nod. "Plus our intrepid reporter, Mr. Saito, and—Zark, isn't it? You're in the wrong part of the embassy. This area is off-limits to kya."

"Except under extraordinary circumstances," Delores said.

"Paragraph three-eighty-nine-cee of the operating code," Nyquist said. "However, *I* decide what constitutes 'extraordinary circumstances.' I'm surprised to see you with them, Mr. Saito. Did Delores make another threat of legal action against you?"

"No," Saito said.

That made Nyquist frown. "Then why are you involved in this? Legally, no one can touch you for following my orders."

"I know," he said, and Delores heard the nervous tremor in his voice. "I can get away with murder . . . only I don't *want* to."

Delores watched Nyquist's frown deepen. "May God save me from self-styled idealists. We'll discuss this matter in my office."

"By all means," Zark said in an affable tone. "That being your home territory, your human instincts should make you comfortable there. Do lead the way."

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Nyquist glared at him, then walked past him and the others.

Escorted by the security officers, Delores and the other three followed Nyquist into his office. As the door closed behind them Delores noted that the chairs for guests had vanished. Not exactly a surprise, she thought; intimidation was one of the darker tools in any diplomat's kit.

Nyquist seated himself behind his desk and looked at his four guests. "I can guess what's happening," he said. "A few hours ago Mr. Saito went to see Zark. A short while later, Dr. Feng received a phone call from Zark, asking for data on the invaders' genetic code. You planned to create a virus which could destroy the invaders, didn't you?"

"Not exactly," Delores said. "The idea is to do a little genetic engineering, and make them more sensitive to cold."

Nyquist's frown told her that he was caught off-guard by that. "I don't see the point."

"The point is to slow down their metabolism a bit," Delores said. "If they can only live where it's hot, such as the tropics, they won't be able to overrun the entire planet. It's a simple fix, if it works."

"'If,'" Nyquist repeated. "Even then it will leave the invaders holding a large part of Kya."

"Quite acceptable," Zark said. He looked around the office, then perched himself on the corner of Nyquist's desk, an act which made Nyquist frown again. "Being human, it bothers you when someone encroaches on your territory, correct? We don't feel that way. Land is just something you walk over."

"Which isn't relevant," Nyquist said.

"Not to you," Jan said. "What's relevant is that the UN wants to let the mnog take all of Kya, because it might be good for business."

"A story no one will believe," Nyquist said. "What proof do you have?"

"I've seen the computer files," Saito said. "And you ordered me to sabotage that plane with the spybots, Mr. Nyquist."

"Did I? Do you have anything in writing? No?" Nyquist smiled. "Well, let me give you something in writing." He opened a desk drawer and pulled out three large envelopes. He handed one to each of the humans in his office and settled back in his chair. "Delores, Mr. Saito, you're both fired. As for our charming member of the fourth estate, you're hereby banned from this embassy."

Delores barely heard him as she tore open her envelope and skimmed through its contents. She felt her temper surge at what she read. "You have no grounds to fire me!"

"The charges are quite explicit," Nyquist said. "And the UN will decide their validity, when you get back to Earth. And if you tell anyone on Earth your version of events, who will believe you? Two disgruntled employees, fired for dereliction of duty? A small-time sports reporter, looking to break into the big time?" Nyquist shook his head.

"There are other humans on Kya," Delores said. She barely noticed when Zark reached out and took her letter from her. "You can't expect all of them to stay quiet."

"We can isolate them from you," Nyquist said, "and make certain they only hear the correct version of events. The UN is working to protect humanity's interests. You will *not* be allowed to interfere with that mission."

"Get a whiff of this," Zark muttered as he read the letter. "Writing this, you're kicking Del and Jan out of your herd?"

"And Mr. Saito," Nyquist said. "They had their chances."

"I get the scent," Zark said. "Needing jobs, they're welcome to work for me. Needing advisors on human behavior, I can use them."

"Until the mnog take over this planet," Nyquist said. "You may all leave now."

Delores hung back as Jan, Zark and

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Saito left the office. Jan looked unhappy about leaving Delores with Nyquist, but she acquiesced at a nod from her. Trusting me to be right, Delores thought.

For a moment Nyquist pretended to not notice that Delores had remained. Then he looked up at her. "If you want a second chance—"

"I don't." Delores sat on the same corner of the desk that Zark had occupied. "I'm curious. Why is it so important to keep the kya from making trouble?"

He looked blank. "What makes you say that?"

"There was that briefing the other week," Delores said. "You acted like an alpha, telling the kya what we would do and acting like they had to accept it. You belittled Zark when he argued with you. That's why you wanted him killed, isn't it? You were afraid the other kya might listen to him, and start doubting what you said."

"What if they do?" Nyquist said. "They won't be around much longer."

"But they'll survive a few more months, won't they?" Delores looked at his face, which had become an unreadable mask. Whatever he was thinking, his effort to hide his reactions told her she was on the trail of something important. "What sort of trouble can they make? Defeat the mnog by themselves? Communicate with them? No, it has to be something else."

Nyquist shrugged. "They might inconvenience us. Riots outside the embassy and our other facilities—well, our defenses are good, but why take chances?"

Delores realized he was lying. "Riot? The kya? All they do when they're upset is demonstrate—impress you with their determination. No, you want them to die off without a fuss. . . ." Her voice trailed off as she realized she had hit the truth. "Of course. You want it to look like they didn't have the *will* to survive—"

"They *don't*," Nyquist said vehemently. "All they can do is follow their leaders, and all their leaders can do is congratulate themselves on how many followers they have."

"And that's a reason to let them die off?" She felt disgusted. "What is it you want? For the other humans here to go home and say that they watched the kya give up without a fight, so they didn't *deserve* to live? That extinction served them right?"

"No." Sweat beaded on his forehead, and Delores saw his hand shake as he wiped it away. "Yes. Listen. It's best for humanity. The UN could become a true world government . . . but it needs support. We can get that from businesses, if we show them that a powerful UN is to their benefit. And it is. The invaders—I didn't set this policy. It was decided back on Earth. There are businessmen who want new markets, new inventions. Something that will benefit all of humanity. The kya can't supply that, but the invaders might."

Delores stared at him for a moment. "Is it worth it?"

"Yes." His voice was hoarse. "It must be."

"You know better." She glanced at the wall clock. By now Jan and the others were away from the embassy and its security force. "And the kya won't go quietly. Did you know that the alphas are chosen by their females?"

"No, I—what does that have to do with anything?"

"Everything," Delores said. "The alphas aren't really leaders. They respond to what the herd wants. Did you notice Zark's surprise when you fired me? Kicked me out of your herd, he called it. You even put it in writing, and he has the letter. You've just discredited yourself. It's going to look even worse when I start working for Zark. I'll be saying I think he's a better leader than you—"

"Which means nothing."

"It means everything to the kya. They won't listen to you any more, but they're starting to take Zark seriously. *He* won't go quietly." She backed away from the desk as if to leave. "And you

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can't kill every human on Kya, or silence them. When they get back to Earth some of them will spread the truth. Think the UN administration can survive that?"

"Wait," he said, as the door opened for her. "This plan of yours . . . adapting the invaders so they can only live near the equator—can it work?"

"It might," Delores said. She heard the uncertainty in his voice—and the hope. She realized he had enough decency in him to want a way out of this mess. "You haven't killed anyone yet. And you haven't gone down in history as a conspirator in genocide. Back down before you do."

After a long moment he took a pen and scribbled something on a notepad. "Try it. Then get the hell out of my sight. You don't care that this will end my career, do you?"

Good guess, she thought. Delores considered saying something, but Nyquist didn't seem worth a comeback. She left the office.

Jan was waiting for her outside the embassy gate. "You okay?" she asked as she hugged Delores.

Delores nodded and gestured at the embassy. "Tell Zark that Nyquist says we can try it."

"That's all that counts."

"Except for having blown my career, and turned the UN against us."

"You have good taste in enemies." She slid an arm around Delores' waist. "Besides, you have a new career, with Zark. This time next year he'll be doing business with the mnog, which means Earth will have to do business with him. Can you imagine how that's going to change Kya?"

Delores tried to imagine it: an influx of new technology from two alien species. For better or worse, Kya was about to change.

No, not for the worse, she thought. She would do what she could to make the changes for the best. And how often did anyone get the chance to help make a new world? "I imagine it's going to be good," she said, and saw Jan answer with a smile. ■

As peace is the end of war, so to be idle is the ultimate purpose of the busy.

— Samuel Johnson

The Chameleon's face reminded Aristotle of a Baboon. Aristotle wasn't much of a looker himself.

— Will Cuppy

But if to every action there is a reaction that is equal and opposite, there is to every advantage, or betterment, an equal disadvantage, or worsenment.

— Charles Fort

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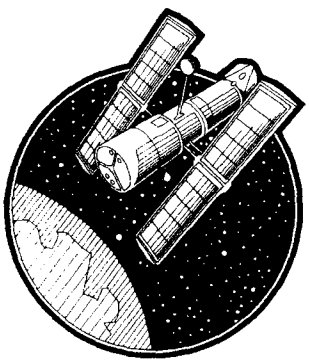
Daniel Hatch

SPACEBIZ 101



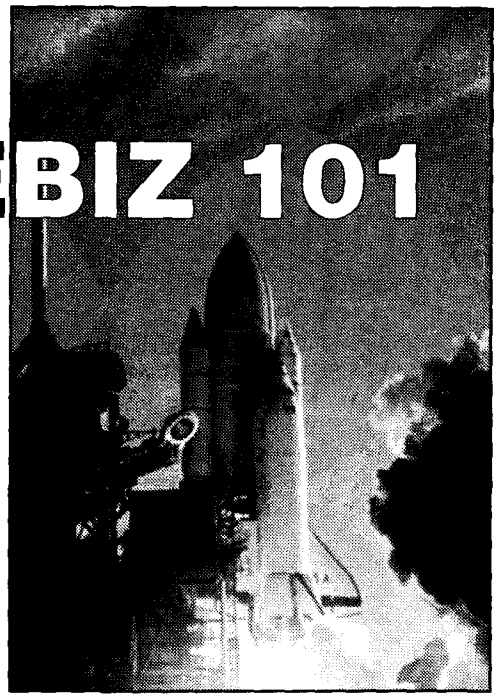


Photo courtesy of NASA

Ahhh, life in space—manufacturing colonies on the moon, mining outposts on Mars, fuel stations among the asteroids, and great rocket-propelled dreadnoughts crossing the void filled with adventurous and enterprising spacefarers.

This vision of humanity's offplanet future is one of the unchallenged assumptions of much science fiction. It combines the romance of a boundless frontier with the realistic considerations of technological challenge. Much of our literature of the world yet to come assumes that there will be commerce and trade and growth and development in space.

But how do we get there from here?

Especially when you consider just how bleak "here" is for would-be spacefarers?

Any rigorous analysis of our future in space has to be based solidly on the current economic realities of spaceflight. And the most important of these is that today the cost of getting from down here to up there is—in every sense of the word—astronomical.

Let's face it, space travel is expensive. Before you draw the first design, before you make the first weld, before you pump the first drop of liquid hydrogen, *you're going to need money.* Lots of money. Big boxes of it. Truckloads of it. Trainloads of it rolling across the countryside. And hundreds of big banks filled to the brim with it.

Just as an example, the tunnel across the English Channel—a project on a scale comparable to space travel—required loans with 265 banks. And because of construction delays, the loans came due before the revenues had begun to pour in, requiring renegotiating the financing with all those banks.

First you have to buy the hardware you'll need to survive. The current rule of thumb is $10,000 a kilogram for Apollo-type equipment. At $10 million a ton, that's a lot of thumb. It's not a hard and fast rule, as we'll see, but it's a starting point.

Second, you have to get it into space. The current launch costs using the U.S. space shuttle are $10,000 a pound,

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$22,000 a kilogram, or $20 million a ton. Again, those numbers can change, but as a starting point they make things look dismal.

Third, and most daunting of all, you need to pay for the money. It's going to take a long time for a space project to start producing income. To finance these projects is going to require no small amount of debt, and at even today's reduced interest rates, that means a fairly hefty debt service. To pay off a loan at an interest rate of 10 percent over 10 years means 70 percent in total interest. So add another $7 million a ton to the design and production costs and another $14 million a ton to the launch costs.

It should be fairly obvious by now why no one is flocking to get into space biz. The start-up costs are immense, the risk tremendous, and the payoff is years down the road.

But cheer up. Things aren't going to remain this bleak for long. Let's look at why.

Money Up Front

Let's start with the financing. We'll get it out of the way first, because it's boring, mundane, and somewhat frightening. After all, compound interest is much more difficult to understand than relativity and orbital mechanics.

The simple fact of life in finance is that when you borrow money, you pay interest. That interest adds to the cost of every project over time and puts pressure on you to complete things on deadline and show an early profit. We have no way of knowing what real interest rates are likely to be on a project like this, but judging from current conditions, we can use 10 percent as a starting point.

It's a good starting point. It's above the current prime rate—the rate banks give their best commercial customers—and it's in line with other risky investments.

If you take it out as a straight installment loan with monthly payments over ten years, you add 70 percent to the total cost of the project and you pay 17 percent of the initial cost each year for ten years. (If you want to make it as appealing as rocket science, think of it as incremental functions of addition and subtraction, where you add the interest and deduct the monthly payment, sort of like calculus.)

In real life, financing a project in space will involve both equity and debt. Equity means stock, shares in the enterprise, which pay can pay a dividend or increase in face value (or not pay a dividend and decrease in value). The debt can be arranged in what are called "zero coupon bonds"—notes that come due in their entirety at the end of the term of the loan with no intermediate payments, or coupons. This is according to David Alexander Smith—a science fiction writer with a real job in finance.

For our purposes, we can avoid controversy—and a lot of truly mind-numbing homework—if we stop right here and just use the 17 percent annual debt service figure.

And while we're on the subject of tedious facts and figures, let's include a big disclaimer right up front. Most of these numbers are just good guesses. Some of them are lousy guesses. They come with no guarantees: past performance is no indicator of future profits, as they say on Wall Street. But they are probably on the right order of magnitude (which means they can be half as much as reality will prove or five times too high). And they will give us a really good idea of the nature of the limits, even if the exact numbers vary from reality. We'll even use several significant figures in our numbers to give the illusion of reality, but I think the likely accuracy of the numbers that get bandied about is still greater than the pretense of precision.

Technology Costs

Now let's look at technology, since you must have technology to get into space, live there, and work there. A

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quick look at *Table 1* shows the cost-per-kilogram in constant dollars for several technology-intensive devices. And it shows you the difference in the economies of scale for different programs.

You can see right away where the $10,000-per-kilogram rule of thumb for space technology originates. That's what it cost to build the Apollo and send it to the moon. It makes sense to argue that it will cost us an equal amount, kilo for kilo, to build something like it. But you also see right away that other systems are not nearly as expensive. Why are the Saturn S-IVB and the B-1 only about a quarter as expensive? Because they built a lot more rockets and bombers than they did moonships.

And when you get down to the Boeing 747, you see real economies of scale take hold. While NASA ended up sending only six Apollo missions to the surface of the moon, Boeing has more than 600 of its top jetliners currently in service worldwide. It's safe to say that the research and development costs for the 747 were paid off a long time ago and the $480 per kilogram is simple construction costs.

What kind of technology do we need to work in space? Here's our first chance to start making some assumptions.

We're not talking about pioneers like the brave souls who spend months at a time in the Mir. That's an Apollo-style program. What we need to look at is the rock-bottom cost to keep a worker in space producing something of value for the people who paid to put him there. In order to justify that worker, we have to make more money in space than it costs to keep him there. That's simple economics.

So what does that worker need? A habitat of some sort, a good-sized container with a life-support system, the equivalent of the log cabin or the sod hut in space.

Let's start with a 10-man habitat that provides each worker with about 25 cubic meters of living space. That's a lot more than you get in a submarine, but there's no need to be that stingy. And it's less than you get in a modern condominium or apartment, so we're not being extravagant. It's more on the scale of a brand new double-wide in the nearest trailer park.

table 1. hardware costs ($/kg)

Boeing 747	$480
Saturn IC	$900
B-1 Bomber	$2,500
Saturn S-IVB	$2,900
Apollo	$13,000

Whatever the configuration of the habitat, there's an important minimum limit on its mass. One of the biggest threats to spacefarers once they leave Earth's atmosphere is radiation. The atmosphere shields us from solar and cosmic radiation, but without it, we are vulnerable. To shield you from that radiation you need mass—10 grams per square centimeter of it (or 100 kilograms per square meter). It doesn't make any difference what this mass is, as long as you've got it around you. Water makes a good shield, so you can put tanks in the outer shell of the structure. And much of the internal construction details of the habitat—lockers, structural support, walls, doors, windows—can be included in this mass if it is strategically placed.

If you assume our double-wide in space is going to be a long box 3 meters by 5 meters by 17 meters, you get a surface area of 300 square meters and a mass of 30 tons.

Now let's get radical with our assumptions. We dare not be afraid to indulge in wild, unrestrained optimism here, because anything less will lead us to a model too expensive to make sense. Let's assume that lots of people are already working in space, enough that the cost per pound of the basic habitat structure—an empty shell without the cost of a life-support system factored in

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yet—is the same as a 747 jetliner, or $480 per kilogram. That means a total cost for a 10-person module of $14.5 million.

Divided by ten people, and you get 3 tons of habitat per person at a cost of $1.45 million.

We can apply the same formula to a life-support system for the habitat.

Having already thrown caution to the wind on the cost of the habitat, let's play it extremely conservative and safe and use a system right off the shelf with a known price tag. The space station life-support system being built for NASA by Hamilton Standard costs $32 million for eight people. That's $4 million and 750 kilograms per person.

We haven't even left the ground yet and we've invested $5.3 million in this worker. Let's throw in her equipment—give her a budget of $200,000 and a mass limit of 250 kilograms.

And we can't forget the cost of the worker herself, either. Let's budget $150,000 per person to get her ready for the program and allow another 100 kilograms in payload.

Finally, throw in a ton of water. It won't cost much, but it'll last a long time—if you don't mind drinking recycled liquids.

The final result, if you look at the top section of Table 2, is an investment of $5.8 million in a 5,100-kilogram package, ready for delivery to the launch pad to be boosted into space. (There's a lot more to Table 2, but let's not get ahead of ourselves.)

Launch Costs

Who said getting there is half the fun?

It may be, but it's more than half the cost. Let's look at the current cost of lifting big things into Low-Earth Orbit. The space shuttle is the standard here. It's hard to find the real cost of launching a payload into orbit in the NASA budget, since the accountants have shifted a lot of those costs off the shuttle's books. But the one everyone uses in public is $10,000 a pound. That gives us a price tag to launch our habitat into Low Earth Orbit of $1.1 billion, or $112 million per person.

The shuttle is not going to be the only show in town for long, however. If things work out, by the beginning of the next century there will be a new launcher on the pad—the Lockheed Martin Venture Star. This Single-Stage-To-Orbit (SSTO) craft is being designed to cut launch costs dramatically. The initial goal is to drop them down to one-tenth of what the shuttle costs.

That would mean $1,000 a pound, $2,200 a kilogram, and $2.2 million per ton, or $110 million for the habitat. And, of course, $11 million per person.

But the folks at Lockheed Martin say they're not going to stop there. Once they've paid off the cost of building the Venture Star—$100 million of Lockheed Martin's money and $900 million of NASA's—they want to cut the costs even more. How low can they go? Let's figure it out.

The way to cut launch costs is not through radical new technology, but through reductions in the cost of keeping the spacecraft flying week after week, year after year. The space shuttle costs so much because of all the people who work for NASA to keep it flying. Airlines, on the other hand, which have to show a profit, have a much lower overhead. Instead of 5,500 people per aircraft, they have more like 50—and half of them are selling tickets.

Most discussions of SSTO designs—or even multi-stage launch vehicle designs—center on reducing the requirements for maintenance and operating personnel. And most of those discussions set a goal of 150 workers per launcher. Coupled with that are some ambitious flight schedules—launches as often as every two weeks for each vehicle.

Now we can use our financing rule-of-thumb—annual debt service of 17 percent of your initial cost—and assume enough launchers are built to bring con-

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table 2. per person costs

Initial Equipment Costs (Current Technology)

	Cost	Weight
Life support	$4M	750kg
Water	0	1,000 kg
Structure	$1.45M	3,000 kg
Other equipment	$200K	250 kg
Personnel	$150K	100 kg
Total	**$5.8M**	**5.1K kg**

Annual Costs

	Shuttle	V'Star	SSTO
Initial Launch Costs	$112M	$11M	$2.3M
Total Initial Costs	$118M	$17M	$8.1M
Annualized Costs *(17% annual debt service)*	$20M	$2.9M	$1.4M
Annual Recurring Costs *($50,000 salary/benefits; $10,000 for 1K kg of food/supplies; launch costs)*	$22M	$2.2M	$510K
Total Annual Cost	**$42M**	**$5.1M**	**$1.9M**
Launch Costs/kg	$22K	$2.2K	$450

Current Technology: *Uses actual space station life support system cost; assumes structure costs of $480/kg.*
Launch Cost Scenarios:
Shuttle–The current system operated by NASA.
V'Star–The Lockheed-Martin Venturestar, the next generation of launcher.
SSTO–A theoretical launcher with development costs paid off and construction costs of $1,000/kg.

struction costs down to $1,000 per kilogram, or $1 million per ton. That's not too far-fetched. The Venture Star, for example, is being financed largely through NASA. Once its design costs are covered, the price for additional spacecraft will be much lower.

For an advanced 100-ton launcher, $100 million is not an unrealistic sticker price. And that works out to $17 million a year once you take care of the financing. Throw in the personnel costs and you get an annual cost of $32 million per launcher. Divide that among 25 launches with a payload of 2 tons per launch and you get launch costs of $450,000 per ton or $450 per kilogram. Table 3 offers a detailed breakdown of these costs. (And again, it gives us something more. But economy of space requires that we wait on that as well.)

That gives us three scenarios—the shuttle, Venture Star, and a theoretical advanced SSTO program of the 21st century.

Recurring Costs

Once you've got your habitat up there, you're going to have to keep it resupplied. The life-support system will need parts. Your workers will need food. Lost oxygen and nitrogen will have to be replaced. The engineers have

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figured out these requirements and put them at about 1 ton per year. For our purposes, the cost of these items is negligible compared to launch costs. One advantage of the high cost of getting into space is that launch costs make the actual cost of an object almost irrelevant. That means it's just as expensive to ship a pound of lobster or chocolate or prime rib as it is to ship a pound of rice and beans. At least workers in space should be able to eat well.

Don't forget to throw in the worker's salary, of course, and $10,000 to pay for the stuff you send up.

You can see from Table 2 (under "Annual recurring costs") that this gives us maintenance costs that range from $22 million a year for the shuttle to $510,000 a year for the advanced SSTO.

Total Annual Costs

Now we can calculate the annual budget for our workers in space—or three budgets, one for each launch-cost regime.

The space shuttle is the most expensive, of course, and puts us right back into the realm of bleak. If you look at Table 2, you can see what we come up with. The costs using the shuttle total up to $118 million. Annualized, with debt service thrown in, that's $20 million. And when you add in the resupply shipments, it rises to $42 million each year.

For the Venture Star scenario, the total cost is $17 million, annualized to $2.9 million, or $5.1 million a year with recurring costs added in.

And for the advanced SSTO program, the total drops to $8.1 million, or $1.4 million per year, and $1.9 million a year with resupply.

If you look at Table 4, you'll see how much each worker in space has to produce for the company that employs them in order to pay for themselves. Figuring 2,000 working hours a year, that means an hourly production of $20,000 with the shuttle, $2,500 with the Venture Star, and $913 with the theoretical SSTO.

table 3. ssto launch costs

	Advanced	Paid Up
Initial Construction Cost	$100M	-0-
Annualized Cost	$17M	-0-
Personnel per Spacecraft	150	Same
X $50,000/yr	$7.5M	Same
Total Annual Cost	$22.5M	$7.5M
÷25 flights/yr	$900K/flight	$300K
÷2 tons/flight	$450K/ton	$150K/ton
	$450/kg	$150/kg

Advanced: *Fully developed systems, development costs paid off, construction costs of $1,000 per kg.*
Paid Up: *Construction costs paid off, no debt service.*

Given the high cost of living in space, it looks at first glance like the only ones who can afford to work there are going to be lawyers, accountants, professional athletes, and movie stars.

And if you look at Table 5, you'll see how much it will cost as the size of the space enterprise increases. It's easy to see that the shuttle is hardly capable of producing an economical long-term space program—not when the price tag climbs towards half the entire U.S. Gross Domestic Product.

Even the theoretical SSTO makes things look difficult in the long run—at least without more cost cutting.

Revenue

So far, all we've looked at is the expense side of the balance sheet. What about the income side? How do we make money in space?

In simple terms, you have to get something from space that is more ex-

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table 4. costs per unit time

	Shuttle	SSTO	SSTO (adv)	Paid Up	Subsidized
Annual	$42M	$5.1M	$1.9M	$493K	$210K
Weekly (52/yr)	$808K	$98K	$37K	$9.4K	$4K
Daily (5/week)	$161K	$20K	$7,800	$1,900	$800
Hourly (8/day)	$20K	$2,450	$913	$237	$100

pensive here on Earth. Since almost everything we use is already here on Earth, you're already working at a disadvantage. But space does offer us a few things—and in abundance.

One of these is energy. Outside the atmosphere, away from the day-and-night cycle of the planet's surface, you have access to all the solar power you could ever want—1,400 watts per square meter, 24 hours a day, seven days a week.

Another of these is precious metals—metals in the platinum group to be specific. Studies of meteorites show that carbonaceous chondrites—the stuff that a large proportion of the asteroids are made of—contain grains of platinum that can be extracted and purified simply and easily in the vacuum and microgravity of space.

A third source of revenue is manufactured goods. One example is computer chips. Future generations of computer chips are expected to abandon silicon and move on to gallium-arsenide as a chemical base, in order to improve speed and performance. And the crystals used as the basis of the chips would be grown in the microgravity of orbital factories.

If you look at Table 6, you'll see a more detailed breakdown of these revenue sources. (And you'll see more figures from the second half of this article. Ignore them for now.)

Solar Power Satellites

The physics of solar power satellites is fairly straightforward. The solar flux is 1,400 watts per square meter. A solar cell of 70 percent efficiency (above today's standard, but within our technological reach) would provide 1,000 watts. Figuring 9,000 hours per year (rounding up from 8,760 to make the math simpler), you get 9,000 kilowatt-hours per square meter. The electric bill here on Earth puts the cost of power at 7 cents per kilowatt-hour. But if you eliminate losses due to inefficiency, overhead costs for the equipment on Earth, financing costs, and a piece of the profits for everyone along the food

table 5. annual costs for large populations

# of people	Shuttle	V'Star	SSTO	Paid Up	Subsidized
10	$420M	$51M	$19M	$4.9M	$2.1M
100	$4.2B	$510M	$190M	$49M	$21M
1,000	$42B	$5.1B	$1.9B	$490M	$210M
10,000*	$420B	$51B	$19B	$4.9B	$2.1B
100,000*	$4.2T	$510B	$190B	$49B	$21B

** Paid off debt not included*

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chain, that drops quickly. We can assume a return to space of 1 cent per kilowatt-hour in order to make the math easier (that's 14 percent of the bill the consumer pays, not an unreasonable fraction). And that means an annual income of $90 per square meter of solar cell, or $90 million per square kilometer.

Divide that by the cost per worker and you can see quickly that a square kilometer of solar power satellite will pay for 2.1 workers with the shuttle, 17.6 with the Venture Star, and 47 with the theoretical SSTO.

But power satellites have an advantage that platinum mining and chip-making don't—the market is much larger. By a coincidence of fate, the average household of four in New England (mine) uses about 9,000 kilowatt-hours of electricity a year. That works out to one square meter of power satellite per home. And one square kilometer of power satellite would serve a million households.

Let's say we build 100 of these things over the next century. That gives us enough power for 100 million households and enough income to support 210 people under the shuttle launch-cost regime, 1,760 with the Venture Star, and 4,730 with the theoretical SSTO.

You may wonder why we don't include the cost of the satellites themselves in this. I wanted to, but realized that most of that material will have to come from offplanet sources. It's economically impossible to build the things without getting building materials from the surface of the moon or the asteroids. And those materials are not part of the Earth-space balance sheet.

In the same way, the folks the satellites and other revenue sources support don't have to work directly for the solar power satellite company. They can be doing almost anything, anywhere in space. What counts is the overall balance of trade between the earth and space. As long as the total amount of money that goes up into space is greater than the money that goes back down to Earth, then the space enterprise as a whole can stay in business. So they'd be scattered throughout space, spending and respending those dollars from Earth on goods that would eventually play a role in getting useful commodities back to the surface.

Platinum Mining

Platinum mining is a slightly different revenue source from solar power satellites. While the number of satellites can increase without limit for years and years and still produce the same revenue, platinum is a fixed market with limited growth. The current market is about 4.5 million ounces per year at a price of $425 an ounce. That's a total world market of about $1.9 billion a year. Nearly all of that comes from South Africa and the Soviet Union. Platinum is a critical metal for much of our advanced technology, however, and the demand for it will grow. If we figure on selling as much platinum derived from space as is currently mined on Earth, we have a budget of $1.9 billion to work with each year.

As you can see, that supports a maximum of 45 people under the shuttle, 372 with the Venture Star program, and 1,000 under the advanced SSTO program.

Computer Chips

You can do the same analysis for the gallium-arsenide computer chip business. Take a look at the balance sheet for Intel Corp., the world's largest maker of computer chips today. Given the cut-throat nature of competition in information technology, you can assume that a better computer chip manufactured in space would take over the Intel share of the market and send those revenues offplanet.

After taxes, that income is $2.3 billion, about the same as the platinum market.

* * *

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table 6. total population supported by space revenues

	Revenue	Shuttle	V'Star	SSTO	Paid Up	Subsidized
Cost per person		$42M	$5.1M	$1.9M	$490K	$210K
Computer Chips	$2.3 B	54	447	1,200	4,624	10,857
Platinum Mining	$1.9 B	45	372	1,000	3,877	9,047
Solar Power	$9 B	210	1,760	4,730	18,250	42,850
Total	$13.6 B	309	2,579	6,930	26,751	62,574

Computer Chips (Intel, Inc. Balance Sheet. Source: 1995 SEC Filing by Intel)

Operating Costs	$8.1 B
Sales	$5.6 B
R&D	$1.1 B
Marketing, General, Administration	$1.4 B
Net Revenue	$11.5 B
Operating Income	$3.4 B
After tax income	**$2.3 B**

Platinum Mining

Current World Demand	4.5 million ounces/year
1997 Price	$425/ounce
Annual Market	**$1.9 billion/year**

Solar Power Satelites

Solar Flux	1,000 watts/square meter
Power Generated	9,000 kilowatt-hours/square meter
@ 1 cent/kwh (14% of cost to consumer)=	$90/square meter/year
or	$90M/square kilometer/yr

Average household in Mass. uses 9,000 kwh/yr. 1 square-kilometer power satellite serves 1 million households. 100 Power Satellites would serve 100 million households. **Total Revenue: $9 billion**

An Early Appraisal

From the initial set of calculations we've made, we can draw some conclusions.

This revenue model is likely to hold true for most of the 21st century, given the current technological outlook, and it gives us a budget of about $13.6 billion to work with.

Under the shuttle, we could support only 309 people on that.

The space shuttle is a lousy founda-

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table 7. per person costs

Initial Equipment Costs (Current Technology)

	Cost	Weight
Life support	$360K	750 kg
Water	0	1,000 kg
Structure	$480K	1,000 kg
Other equipment	$200K	250 kg
Personnel	$150K	100 kg
Total	$1.2M	3.1K kg

Annual Costs

	SSTO	Paid up	Subsidized
Initial Launch Costs	$14M	$465K	0
Total Initial Costs	$2.6M	$1.67M	0
Annualized Costs *(17% annual debt service)*	$441K	$238K	0
Annual Recurring Costs *($50,000 salary/benefits; $10,000 for 1K kg of food/supplies; launch costs)*	$510K	$210K	$210K
Total Annual Cost	**$950K**	**$493K**	**$210K**
Launch Costs/kg	$450	$150	$150

Advanced Technology: *Construction costs for life support systems and structure are $480/kg. Structure reduced to 1,000 kg launched material, remaining mass comes from space resources.*
Launch Cost Scenarios:
SSTO–Costs include debt service on construction loans for launcher.
Advanced Technology–Construction loans on launcher paid off.
Subsidized–Launch costs and initial construction of habitat paid off.

tion for any serious commercialization of space. It's far too expensive and far too easily surpassed, once the technology is designed to be cost-effective instead of just politically palatable. The small numbers of people that the shuttle could support are inconsequential when it comes to the needs of a developing global market with billions of consumers.

Venture Star doesn't advance much towards the goal of a thriving offplanet community—not with the promise of only 2,579 workers maintaining the infrastructure that created 100 solar power satellites. Someone's going to be working a lot of overtime in that scenario.

Even the theoretical SSTO vehicle that offers us rock-bottom costs (you can't build and operate a rocketship more cheaply than that) can support only 6,930 people. This is hardly the stuff of grand science fictional space empires.

Is There A Limit On The Sky?

Now comes the time to start cutting costs. There must be some room for improvement. Let's see where it is.

We can certainly expect the cost of technology to drop as more and more units are produced. That $480 per kilo-

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gram figure for the 747 is probably a pretty solid floor on which to base our projections. If life-support technology drops to that price, we could cut the cost of the basic per-person habitat to $360,000—more than an order of magnitude.

And there are savings to be made in the structure. If all we need is mass to protect us from radiation, there's plenty of that in space. Any settlement on the surface of a planet or moon has all the mass in the world available to it. And any settlement in space can use surface materials from the moon, asteroids, or other planets. As long as the fuel to move them into place is produced off-planet, they don't figure into our balance sheet.

We still have to send up things that can't be manufactured cheaply in space and a certain amount of structural elements. But a total of 10 tons for our 10-man habitat sounds reasonable. Remember, we're talking about your average double-wide here, something the size of a large tractor-trailer.

Now if you look at Table 7, you'll see some familiar-looking figures. But these have changed. The new habitat with 1 ton of structure per person and a discount life-support system comes with a sticker price of only $1.2 million.

If we work out the subsequent costs, using our theoretical SSTO system, the annual costs per person drop to $950,000—or half that under the more costly custom-designed habitat of the first model. But doubling the small numbers of workers supportable with the more expensive equipment doesn't get us very far.

So let's look at the rocketship. The assumption that you have to pay debt service on the thing only goes so far. What if you don't have to borrow the money to buy the thing in the first place?

Who has that kind of cash laying around? Governments do. And the kind of big businesses that earn more than $10 billion a year. You can order up an SSTO tomorrow if you're big enough and willing to take the risk of justifying it to your stockholders or your constituents.

If you're not big, you can always pay off the debt. As the technology ages and more robust designs are developed, you can begin to use your craft beyond the age of the mortgage. Once you've paid off your debt, your costs drop dramatically. Look back at Table 3, in the second column that you were supposed to ignore, and you see that they fall to $150 per kilogram.

And if you look at Tables 6 and 7 again, you can see what that does to the worker's bottom line. Using the cheaper habitat and operating your own, paid-up SSTO to get them into orbit, your workers cost only $493,000 a year. That's an hourly cost of $237. And that's low enough to support 26,751 people on the power-platinum-chips economy.

It's pretty clear that launch costs are going to be a problem no matter what we do. It's still going to take a lot of people to run a rocket line and life is going to be seriously different when a kilogram of coffee, sugar, nails, or floppy disks cost you upwards of $450. And since the initial cost of launching a habitat into space is the biggest share of our operational costs, we start to wonder if there issome way we can get the biggest of these off our books.

Wouldn't it be nice if the government paid for it? If they put up $1 billion, we could house 2,000 workers. Ted Turner offered that much money to the U.N., so private individuals can't be ruled out as a source of subsidies. At least at first, spacebiz will be small enough that the patronage of the wealthy and powerful can make a big difference.

Another way of getting someone else to pay for the initial investment is to wait until they fail and buy up their assets at a discount. The history of railroading in the United States consists of companies building railroads and going bankrupt, only to be bought up by new companies that ran the rail-

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table 8. growth of space population over time
(starting with 100 in 2010)

YEAR	POPULATION	2015-2035	
		Annual Growth: 15%	**Initial Cost**
2015	201	448 Newcomers:	$850M
2020	404	2,178 Workers:	$1B – $2B
2025	813	813 Equity-holders:	$150M
2030	1,636	Cost in 2035:	$2B – $3B
2035	3,200		
		2040-2060	
		Annual Growth: 10%	**Initial Cost**
2040	5,299	3,240 Newcomers:	$6B
2045	8,534	10,274 Workers:	$5B – $10B
2050	13,745	13,745 Equity-holders:	$3B
2055	22,137	Cost in 2060:	$14B – $19B
2060	35,652		
		2065-2085	
		Annual Growth: 5%	**Initial Cost**
2065	45,501	5,749 Newcomers:	$11B
2070	58,073	40,864 Workers:	$20B - $40B
2075	74,117	74,117 Equity-holders:	$15B
2080	94,595	Cost in 2085:	$46B - $86B
2085	120,730		

roads—and went bankrupt. It was a cycle that continued for several iterations before companies that could run railroads without losing money finally emerged.

But in the end, the biggest source of subsidy will be the steady march of time. We can assume that the habitats themselves will be sturdy enough to last much longer than the ten years that we will be paying for them. There are going to be a lot of mortgage-burning parties as the space population ages.

The equity base for any space settlement will grow at the same rate as the settlement itself, lagging in size by the average length of the debt incurred to build it—in our model, ten years.

And that means that a second wave of workers will grow out of the efforts of the first. For them, the initial cost of settlement will be paid up and the only cost will be the annual maintenance required for food and life-support. Under the best of circumstances, that will amount to as little as $210,000 a year.

And that brings the hourly cost of a worker in space down to $100.

That's not bad. For one thing, it means that you only have to work an hour and a half to make the cost of a kilo of coffee. And for another, it means you can support as many as 64,000 people on the $13.6 billion budget we've set for ourselves.

How Long Can This Go On?

None of this will take place in a vacuum.

Or rather—since it will all take place in a vacuum—none of this will take place in the virtual world of a computer simulation. It is a process that will continue in the real world over real time—years, decades, and beyond. The slow but steady growth of those working and

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living in space will produce its own special resonances.

If you look at Table 8, you will see what some of them are.

We can start with the optimistic assumption of 100 workers in space by the year 2010. That would require a handful of pilot projects in orbit and maybe on the surface of the moon—not your standard space station and moon base stuff, but real commercial operations making computer chips, extracting minerals and ice for later use, constructing large orbiting structures.

We can also assume a growth rate of 15 percent for the first generation. That's a pretty rapid pace—doubling every five years. But with the numbers so small, it's probably a conservative estimate. Some companies double in size every year. That carries us up to 2035 and a population of 3,290.

Now more than 400 of these arrived in the last 12 months. If they paid full price for their tickets, it will cost the entire cohort $852 million to stay there for a year. Of the remaining 2,800, about 2,000 will have to come up with $1 billion if they bought a $150/kg ticket, to $2 billion if they bought a $450/kg ticket, to cover their costs. The last 800 will be the equity-holders, the ones who have burned the mortgage and only have to come up with the bare minimum—a total of $170 million for the lot of them. For the whole space enterprise, an annual rent of $2 billion to $3 billion.

If we slow the growth rate down to 10 percent for the next generation, we reach the year 2060 with a population of 35,652. That's still a hefty growth rate, but one that's hard to sustain with a lot of heavy management of resources. That includes 3,240 newcomers at a cost of $6 billion a year, 10,000 workers at a cost of $5 billion to $10 billion, and more than 13,000 equity-holders at a cost of $2.9 billion. The total rent has gone up to between $14 billion and $19 billion.

Another generation and we drop the growth rate to 5 percent. That's more realistic, given the larger numbers involved. And it still produces substantial numbers by the year 2085.

By then, the space enterprise has grown to 120,730. The 5,749 newcomers will cost $10.9 billion to keep them in coffee and lobster for the year. The 40,000-plus long-term workers will have to produce $20 billion to $40 billion in value to justify their continued employment. And the 100-year-old equity-holder who's been there since the beginning will be part of a cohort that is 74,000 strong.

Of course, by that time, there will be more than enough ways to support the offplanet population without relying on a 1,000-kilogram shipment from Earth each year for each person. And that means that all bets are off, the entire model has outlived its usefulness, and a new one will be needed.

After all, the inhabitants of Jericho, the oldest urban settlement on the planet, invented agriculture when the city had only 3,000 inhabitants. ■

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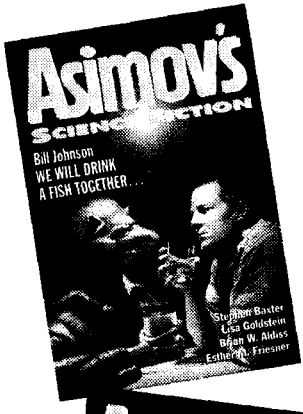

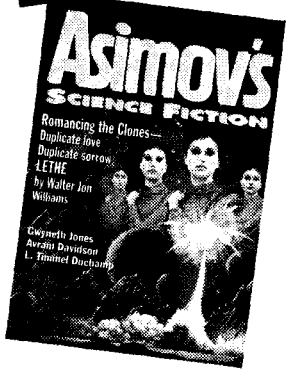

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Michael A. Burstein

Absent Friends

New discoveries confer new abilities—but the best ways to use them are not always what you'd think.

Illustrated by Randy Asplund-Faith

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Jack hated offices, especially the offices of scientists working in government laboratories. Such sterile, antiseptic places. He had difficulty believing that intellectual stimulation could come out of such bland surroundings.

He hated jackets and ties as well, but had felt obliged to wear a suit to this late Monday afternoon appointment. Every few seconds, he would notice his hands fidgeting at his visitor's badge, and he would pull at his tight collar in an effort to make himself less nervous and more comfortable. It didn't work.

Most of all, he hated waiting. A secretary had let him into the project director's office, but fifteen minutes had passed since then, the afternoon was slowly approaching evening, and still the project director had not arrived.

Finally, the door opened, and Dr. Anita Zahn walked in. Jack felt glad now for the formal way he had dressed. Zahn was a small woman, with short black hair, and she wore a red suitjacket. "Sorry to keep you waiting, Mr. Levinson. We had a problem with the Gate."

Jack stood as Dr. Zahn walked around him, then resumed his seat when she sat down behind her desk. "It's OK," he replied. "I hope the Gate's fine."

She regarded him with pursed lips for a moment, then said, "The Gate is operating normally. Now what can I do for you?"

Her businesslike manner put Jack on his guard. "Dr. Zahn, do you know who I am?"

She nodded. "You don't get to be the head of the Gate project without being briefed on its history, Mr. Levinson. You were the local math teacher from Waxahachie High School present at the formation of the first Einstein-Rosen bridge, a few years ago."

"Two years ago," Jack corrected her. "And there's more to the story than that."

"I know. The death of your friend. Tragic."

Tragic. Was that the sum total of Daniel's life and death? One word? Tragic? Jack thought back to that October afternoon, when Daniel and he did what they did every Sunday: bicycle around the ring of the old, abandoned Superconducting Supercollider. Well, it certainly wasn't abandoned anymore. The explosion in the ring that had killed his friend led the scientists to discover another universe, one in which the SSC was operating and leaking antimatter into this universe. Suddenly, the two different SSC experiments had become hotbeds of activity, in both particle physics and the attempt to build stable Gates to other universes. Particle physics had made great strides, but to date, no other universes had been found.

And it had all started because of the death of Jack's best friend, Daniel Strock.

"Doctor," Jack said slowly, "it's because of my friend that I wanted to see you."

She nodded. "Please continue. I don't have all day." Her brusqueness was in great contrast to the politeness Jack had experienced from the other scientists two years ago.

Well, if she could be direct, so could he. "I need to use the Gate."

"You need to use the Gate," she replied evenly.

"Yes."

"Because of your friend."

"Yes."

She sighed. "Mr. Levinson—"

"Jack, please."

"Jack." She smiled momentarily, then frowned. "I'm afraid that's impossible."

He shook his head. "Hear me out."

"But—"

"Just listen, please." He looked her right in the eyes. After a second, she closed her eyes and nodded.

Jack took a deep breath, then spoke. "Dr. Zahn, how old do you think I am?"

Zahn seemed surprised by this question, but answered, "I don't know. Thirty?"

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"Close. I'm twenty-seven. And in all that time, I've only had one good friend in all the world. And that was Daniel."

Jack stood up and paced. "We had a unique friendship. We grew up together in New York, but never liked the feel of a big city. We went off to two different small town colleges and drifted apart, but kept in constant touch by phone and e-mail. We both loved and studied math, and when we had a chance to end up teaching together here in Waxahachie, we took it."

Jack stopped pacing. "We really enjoyed a lot of the same outdoor activities, like hiking, or—or bicycling. And two years ago, when I saw Daniel die in that explosion—for a while there, I didn't want to go on."

He sat down again and leaned forward. "But one thing kept me going. The scientists working on the project apparently had doubles in the other universe. I remember, when they invited me to be present at the time of first contact, that the SSC director here and there looked exactly the same. And I thought that maybe, just maybe, my friend Daniel was still alive. In the other universe."

He rubbed his eyes and sighed. "I want your permission to go into the other universe, to look for him. I want to see my friend again. I need to see him."

His appeal finished, Jack leaned back, and looked directly at Zahn.

She sighed and put on a noncommittal expression. "Look, just because you were there from the beginning doesn't mean you have any proprietary rights over the Gate. It's not like we're running a travel agency here, or even an import-export business." She put her hands together and asked, "How much physics do you know?"

Jack shrugged. "A little. I took it in college. But I'm mostly a math person."

"Well, let me explain it to you in a way you can understand." Her tone didn't sound like she meant to be patronizing, but to Jack's ears, her phrasing was just as bad. Wryly, he thought that she could use a lesson or two on how to teach.

She continued. "First of all, we're still not even sure how the bridge between the universes formed. Yes, we know that the extremely high energies of the beam broke through the barriers between the universes, but we've barely even begun to understand the physics behind it. There are so many questions we still need to answer, and the most important one is why we ended up linked with this particular universe."

"Universe Beta," Jack said.

Zahn nodded. "I see you've been keeping up with the news. We've never had to name our universe before, so Alpha and Beta became the official designations. Over there, they call them One and Two." She smiled. "We're Two, of course."

"Of course," Jack murmured.

"Like I said, we've barely begun to understand the physics behind the situation. But we do understand a few things. Apparently, this phenomenon is also based upon the many-worlds interpretation of quantum mechanics, developed by Hugh Everett at Princeton in the 1950s. Every time a decision is made, the Universe splits into many different universes, and in each one the decision is different. For example, today I ate cereal for breakfast, but in some other universe perhaps I ate eggs."

Jack nodded. "I do watch *Star Trek*," he said.

Zahn winced; apparently, that was the wrong thing to say. "Anyway," she continued, "if Everett's theory is correct, then already we have the question of why we're in touch only with this particular universe, and no other. After all, if there are presumably billions of SSCs running beams in all these multiple universes, then why haven't they all leaked into ours?"

Jack tried to salvage his part of the conversation. "Perhaps Universe Beta resonates with ours on some fundamental level."

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Zahn's eyes widened. "That *is* the hypothesis we've been working on, yes. But we don't know what the connection is, and there's another problem to keep in mind."

She looked Jack straight in the eyes. "*Everett's theory does not allow for actual travel or contact between the universes.*"

Jack was puzzled. "But we *are* in contact. If anyone knows that, *I* do."

Zahn nodded. "That's exactly the problem. We don't completely understand why this is happening. But what we do know is that when we send matter through the Gate, it affects the resonances between the universes, effectively pushing them apart. The rate of the separation seems to be proportional to the mass sent through. In other words—"

Jack interrupted. "In other words, if you send too much stuff through the Gate, you'll push the other universe away."

Zahn nodded. "About the only thing that we can trade safely back and forth is information. We do use the Gate on occasion to send small things back and forth to study, but we never send a person across. That simply isn't possible."

Jack faced the floor, studying his shoes. "Then you're saying that you won't help me."

She shook her head sadly. "Not won't. Can't." After a moment, her somber face brightened. "There is one thing I could do for you."

Jack looked up hopefully. "What?"

"Well, I could ask the other scientists in Beta to search for your friend. We could bring him to the Gate, and you can meet him then."

Jack shook his head and said, "No, thank you." He didn't bother telling her that her predecessor, Dr. Pratt, had tried to locate Daniel Strock last year, to no avail. Or at least, he had claimed to an effort. Dr. Zahn was obviously not as well briefed as she thought.

"In that case . . ." Zahn spread her arms out in a gesture of helplessness.

Jack shrugged. "Guess I'll have to forget about it. Thank you for your time." He stood up to leave.

"Wait," Zahn said, standing up as well. Hesitantly, she put a hand on his shoulder. "Jack, a piece of advice if I may."

He nodded.

"I'm really sorry about your friend, but—but you really ought to put it behind you. Even if you did find him on the other side of the Gate, it probably wouldn't be the same."

Jack felt a tear in his eye. "I had to try," he said.

Jack biked home to his apartment, upset and depressed. He briefly considered heading over to Getzendaner Park, to take advantage of the beautiful bike trail, as it was still a lovely afternoon. But after a long day of teaching and the late appointment, he wanted the solitude of home, and given that the Cow Creek Country Classic Bike Rally was coming up next month, there would probably be a lot of other people out on the trail.

He lived in a relatively new apartment building, on the same block with some of the gorgeous old houses for which Waxahachie was known. From what Jack had gathered, long-time residents had made a big stink when the huge building was constructed. But it was one of the few places where a young high school teacher could afford to live.

At the front door, he removed his helmet, took out his keys, let himself in, and walked his bike into the building. He lived on the first floor, making it easy for him to bring his bike in and out of the place.

After getting his mail without looking at it, Jack opened his apartment door and put his helmet and bicycle away in the front closet. He walked into his bedroom, removed his jacket and tie, and changed into sweats and a T-shirt. Then he sat down on the edge of his bed and rubbed his eyes.

A few minutes later he stood up and wandered around his apartment, from

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the bedroom to the living room and kitchen, and then back to the living room again. Small place, without many furnishings, but that had never mattered before. Daniel and he had usually gone out places together. They had even double dated once, although that didn't work out. Both Daniel and Jack had felt married to their work, which was usually more than satisfying.

But now Jack wasn't so sure. He felt discontented with his life. His place, which had always felt cozy before, had most recently taken on an air of loneliness. It pervaded him, making him feel hollow inside.

His grumbling stomach reminded Jack that it was close to dinnertime. He briefly considered cooking an elaborate meal—just the kind he had liked to prepare for him and Daniel. But he couldn't get up the enthusiasm to do it. Instead, he opened a can of tuna, made a sandwich, and plopped down on the sofa in front of the TV to watch the news.

He couldn't bring himself to pay attention, so he left the TV on for background noise and sorted through the letters. Junk mail, mostly. People hardly wrote personal letters anymore. But one letter bore the name and return address of Rachel Larsen, an old girlfriend from high school. He opened it and read it with scant attention; it was mostly about Rachel's new kid and new job, in that order. But then she got into some more personal stuff which caused him to sit up.

"*. . . you've been brooding for two years now, Jack. I know you don't have any other close friends in Waxahachie. Perhaps it's time you came back to New York, to your family and other friends. You need people around you, people who know and care about you, and you're not getting that in Texas.*

"*Jack, let me finish this letter with one question: would Daniel have wanted you to mope around like this?*"

Jack read over the last few paragraphs again and again, trying to assimilate Rachel's words. Leave Waxahachie? He couldn't see himself doing it. Perhaps it was a small town, but it had a certain charm to it. If he needed a big city, well, Dallas was but a short drive away. He didn't need to go back to New York; he just needed his friend Daniel again, impetuous, fun Daniel, who always knew just what to do with life. . . .

Jack drifted off to sleep on the sofa, Rachel's letter clutched in his hand.

The next day, Tuesday, was another school day, and Jack zombied through the day, barely nodding his greetings to colleagues and students in the halls. He always planned out his lessons well in advance, which made it easier to teach on days that he just didn't want to think. In the morning, he taught Precalculus and Algebra II; his day ended with another section of Algebra II, and Geometry.

It was in the middle of that last class that the thoughts came unbidden to his mind. He had just turned his back on the apathetic students to write another line of a proof when the ennui overwhelmed him as well. *What am I doing here? Do the students really care? Will I be stuck here teaching Pythagorean Theorem over and over for the rest of my life?*

He hesitated, his chalk poised above the blackboard. What could he do? He had twenty minutes left to class and no choice but to continue teaching, but his heart wasn't in it anymore. He gritted his teeth and reminded himself of the few students who did care, the ones who made him enter this profession in the first place.

That got him through the class. By the time the bell rang, Pythagorean Theorem had been proven once again. He sat down at his desk and stared out into space as his students shuffled out of the classroom.

Except for one. Donald Primrose, one of the better students, gathered up his things and hesitated at the door. Once the rest of the class had exited, Donald turned back to Jack. "Mr. Levinson?"

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"Yes, Donald?"

"Um—are you all right? You seemed out of it for a while there."

Jack smiled. "I'm fine, Donald. Thanks for asking. Don't forget the late homework you owe me."

"Um, OK." Donald left, and Jack went back to staring into space. He really ought to get up, he thought. Get up, go home, grade papers . . .

It all seemed so banal, so unimportant.

Jack looked up at his door. If Daniel were still alive, he would come careening in here any second, laughing, joking, suggesting a drive to Dallas or a walk in the park—or something else. Maybe even bungee jumping; Daniel was always more of a daredevil then Jack.

Jack stared at his door for five minutes. It didn't open.

With a sigh, Jack got up and collected his things. His friend Rachel was right. He couldn't live like this anymore. Not without Daniel.

As Jack swung his pack around on his back, something fell out—his visitor's badge from yesterday's appointment. Jack smiled at the realization that they had never bothered to take it back. The SSC might be a government laboratory, but it was a relaxed one, and security tended to be somewhat lax there. The badge was only good for yesterday, anyway, and Jack picked it up, intent on throwing it out.

He brought it to the trash can and hesitated. He studied the badge. The date was handwritten and not very clear. He could use the badge to get back into the facility today, if he wanted. And that meant . . .

Whistling, Jack stuck the badge in his pocket, and headed home. He had to get a picture of Daniel and make a few phone calls.

Building G, a small white cube, sat alone in the middle of the dry grassy plain above a section of the actual collider, which was buried underground. As Jack biked towards the building, he remembered that its location was the same as where the breakthrough had first happened, when the two universes had merged for a brief time in a small volume, allowing the people of the two different universes to communicate directly.

The night was cool, a full moon hung high in the sky, and Jack paused for a moment to inhale the clean air. He dismounted and covered the rest of the distance to the building on foot, wheeling his bicycle along with him. The glass door in front was locked, but Jack rang the bell, and in a minute a man came to the door and opened it from inside.

"Jack Levinson?"

"Yes, that's me."

He opened the door wide and grinned broadly. "Pete Gallagher," he said, and shook Jack's hand vigorously. "Come in, come in! It's eight o'clock, you're right on time!" He practically pulled Jack inside, the bicycle dragging along.

Gallagher was large, taller and broader than Jack, but his size was mostly due to weight, not muscle. He wore a button-down shirt with the collar open, and a badge that identified him as a Technician. "Let's get right to it—the Gate's this way." He wheezed as they walked down a white-walled hallway, but kept up a fast pace.

"Sorry to have bothered you," Jack said.

"No problemo! You're a bit of a celebrity around here, you know that, don't you?"

Jack stopped in his tracks. "A celebrity?"

Gallagher continued walking, forcing Jack to do the same. "Yeah, well, I mean, as you were the first one to see the universes converge. I've always wanted to meet you. That's why I was so glad when you called this afternoon. So they've never let you see the Gate before?"

"No," Jack said, and then did some-

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thing he hated. He lied. "I'm really grateful to Dr. Zahn for letting me see it tonight."

"Yeah, she's aces. Not like Dr. Pratt. He kept a tight fist on everything."

Jack didn't know what to say. He agreed that Pratt had been hard to deal with, but he had offered what help he felt he could. Of course, Zahn had done the same, and if she hadn't been the current director, it probably would have been much harder for him to convince Gallagher that he had permission to see the Gate.

They stopped at a door. Gallagher took out his passkey, and started to slide it through the electronic lock when he slapped himself on the forehead. "Oh, I forgot! I have to see your badge." He shrugged. "Regulations, you know."

Jack nodded and showed the badge to Gallagher. He quietly breathed a sigh of relief when Gallagher gave it a cursory glance, not even taking it for a closer look.

"OK." He grinned. "I should probably warn you that the Gate is an impressive sight, but you've already seen the effect before, haven't you? Here we go!" He slid his passkey through the lock, and the door opened with a loud click. They entered the room.

Gallagher headed over to a control panel on the nearby wall while Jack took in the sight at the center of the room. The Gate looked nothing like a gate. Jack had been expecting a normal rectangular-shaped doorway, the size of a person, through which the other universe would exist just like another room. Or perhaps it would appear to wobble and ripple, like the other universe did the first time they were truly brought together.

The Gate was something entirely different. It looked as if a sphere of electrically charged air or water hovered in front of them. It sparkled, it crackled with noise. The other side of the room was only visible around it; inside, it appeared to be nothing but a mass of turbulence, a trapped ball of lightning, thunder, and wind.

"Wow," Jack whispered. He could barely hear himself over the noise.

Gallagher grinned at him. "Sorry we can't turn it off," he shouted. "The scientists are afraid that if we close the connection, we may lose contact permanently. And I'm not just talking about Dr. Zahn. This comes from on high."

"How does it work?"

"What do you mean?"

"Well, is it safe to go into that?"

Gallagher laughed. "Scared of all the special effects? Relax; the Gate turbulence can't harm anything. At least not as long as we're controlling it from right here. We pass stuff through all the time."

"Really?" That didn't seem consistent with what Dr. Zahn had told him. Could she have been lying? "Like what?"

"Oh, notebooks, equipment, things like that. Anything that will help us understand the Gate. That's how we work with the other scientists, in Beta."

"Do—do people ever go through?"

Gallagher fiddled with a few controls before replying. "Very rarely, although all of us techs have been through at least once. It's like the world's most thrilling rollercoaster ride." He looked around conspiratorially. "Would you like to go through?"

Could it be this easy? "Really? Do you mean it?"

Gallagher grinned and shook his head. "Nah! I really can't let you. You understand."

Jack felt deflated. "Sure. Sure, I understand."

Gallagher nodded and turned back to the control panel. In a moment, Jack knew, Gallagher would suggest that Jack leave. After all, his lie only covered the chance to see the Gate, and now that he had, there would be no other excuse for him to stay.

It was now or never. Offering up a quick prayer that he wouldn't hurt anyone on the other side, Jack lifted his

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bicycle and, with all his might, heaved it into the Gate. It hit the boundary of the sphere, crackled, fizzled, warbled, and vanished.

Gallagher reacted to the quick change in the noise from the Gate. He snapped his head around and shouted "What in the—"

Jack had no time. He shouted, "My bicycle got sucked in! I'll go get it!" and jumped.

If the Gate seemed scary before, what happened next was positively terrifying. Jack remembered the only time he had actually seen a small portion of the two universes come together. The people of the other universe had seemed transparent and insubstantial. Their bodies had appeared to stretch and compress, as if space were a wave moving through them.

Now, that seemed to be happening to Jack himself. It confused him, because he knew that what he had seen before was merely visual, an effect of the two universes merging temporarily. But that was no longer the case. He felt his own body stretch and distort, making him long and thin, then short and fat. It was like being a rubber doll, tossed around by the eddies of the Gate.

He felt like he would vomit, but he had lost the sense of his own body. He became a disembodied consciousness, floating in a sea of white sparks, surrounded by overwhelming noise and bright light. He tried to concentrate, to focus on anything, but there was nothing around him, nothing at all.

Time seemed to stop, and it seemed to go on forever. Space expanded, space contracted. The Universe ended, the Universe was born.

Presently, Jack became aware of his own breathing. Slowly, feeling returned to his body, first to his legs and feet, then to his arms and hands, and finally to his head.

His eyes snapped open into a bright light, which made him blink a few times to clear the sudden tears.

After a moment, he realized he was lying on his back upon a cold concrete floor. The bright light was the Gate, floating above him and to the side, looking exactly the way he remembered it.

He stood up quickly and looked around. The room looked exactly the same, but with two minor differences. Off to one side, his bicycle lay on the floor, apparently undamaged.

And Pete Gallagher was nowhere to be seen.

Jack walked over to his bicycle as quickly as he could, but carefully. He felt slightly dizzy, presumably an aftereffect of jumping through the Gate. He righted the bicycle, walked it over to the door of the room, then stopped short and laughed.

He was heading towards the wall. The door was on the other side, in this version of the room.

He shook his head, turned around, and exited the room. Fortunately, there was no one else around in the hallways. It had been a gamble, but it had paid off. When Jack had called the main number for Building G back home in Universe Alpha, he was counting on the fact that the building would normally be unstaffed at night. Pete Gallagher had been the only one around shortly after 5 PM, and he agreed to let Jack come visit after Jack's lie about having Zahn's permission, a lie which couldn't be checked until tomorrow. Well, the Building G in Universe Beta was also unstaffed at night, which made Jack's life that much easier. He imagined what it would have been like for him had he emerged into the middle of a normal workday, with technicians everywhere, doing experiments, and he shook off the shudder of how quickly they would have sent him back.

Come to think of it, after that weird passage, he wasn't sure he ever wanted to go back. It was similar to his fear of flying. He wouldn't mind being home again; he just didn't want to have to pass through the Gate to get there.

Jack quickened his pace to the build-

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ing's exit. Although he didn't think that Gallagher would follow after him immediately, the possibility was still there.

He emerged into a clear, cool night, similar to the one he had left behind on the other side. The moon was even full, although it hung slightly higher in the sky, which made sense given how long Jack had been unconscious. Jack inspected his bicycle for damage. It appeared unhurt from its trip through the Gate, so Jack mounted it and headed towards town.

Specifically, he headed towards a motel he knew was located a short ride away from the school. Obviously, Jack couldn't head "home," as his apartment was probably occupied by someone else in this universe. But he had already acknowledged and prepared for this problem. He would stay at a motel tonight, head over to the school tomorrow, and begin asking around for Daniel.

Less than an hour later, he arrived at the location of the motel, and had a small surprise. The motel looked the same, but it sat on the other side of the street from the one he expected. Jack shrugged. A minor inconvenience, nothing more. He crossed the street, locked his bicycle to an outside post, and entered the motel.

The lobby was a tiny room with two tables and a desk, at which sat the clerk, a young man with nicely combed black hair and a nametag on his red jacket. He looked up as Jack let the door fall shut with the tinkle of a bell.

"Good evening, may I help you?"

"Yes, I'd like to rent a room for—for the next two nights." That should be long enough.

"Certainly, sir." The clerk consulted the computer in front of him and hit a few keys. "And how will you be paying for this?"

"Visa." He handed over his credit card, and the clerk ran it through the computer. After a moment, the computer beeped and he gave Jack a funny look.

"Sorry, it doesn't seem to be valid," he said, and he handed the card over.

Puzzled, Jack took it and said, "Oh, well, then I'll just pay cash." He reached into his wallet to take out some bills, and paused with his hand around a twenty.

It suddenly hit him that his credit card didn't work in this universe; what guarantee did he have that his money looked the same as their money?

Answer: absolutely none. The credit card was one thing, but if the clerk decided that his money was no good, Jack could easily find himself locked up in a jail for the night, trying to explain why he had tried to pass off such obviously fake money as the real stuff.

He stuffed his wallet back into his pocket, mumbled, "Never mind," and rushed back into the cool night.

Where could he go now? As he unlocked his bicycle, he first considered heading to his apartment building. Maybe his keys would work, and the current resident might be out of town, and he could—

No. That was both stupid and dangerous. At the very least, he might get arrested for breaking and entering. At the very worst, another version of himself might live there, and he'd have a hard time explaining his presence.

Perhaps he could check a phone book for Daniel's name. After all, if he could find Daniel tonight, he could probably introduce himself, sleep over—

No, that wouldn't work either. Jack knew that Daniel didn't live in Waxahachie Beta, at least under the name of Daniel Strock, because that was something Dr. Pratt had checked for him. The motel looked like the best bet, and maybe, just maybe, his money would be good here after all. Perhaps the first thing he needed to do was to check his money against local currency—

A sudden dizziness overwhelmed Jack for an instant, and he braced himself against his bicycle. It passed quickly, and Jack blamed the excitement of the

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night. But still it frightened him, and disrupted his previous train of thought. He now realized that he didn't want to do much of anything until he found Daniel. Was all this really worth it? Maybe he should just go back to the Gate and his own universe, apologize to Pete Gallagher, and go home.

But then again—Jack took the picture of Daniel out of his wallet, studied it for a minute, and for the umpteenth time read the inscription on the back. "Jack—You have always been, and always will be, my friend—Daniel."

He went to Getzendaner Park, and slept under the stars.

The next morning, after freshening up and cleaning himself off as best as he could in one of the park's restrooms, Jack headed over to Waxahachie High School. It was the same, but different.

Jack couldn't quite put his finger on it. The building looked like the one he knew, and the location was correct, but there was something subtle, something just off, about the place. He thought about it as he locked his bicycle to a post and watched the flow of students into the school.

He yawned and stretched once his bicycle was secure, and joined the throngs of people going into the school. Self-consciously, he rubbed the stubble on his chin and hoped no one would take too much notice of his slightly disheveled appearance. Fortunately, the buzz of student conversation dominated the interest of the masses around him, and no one paid him much attention.

There was one obvious place to head towards once Jack was inside, and that was the Mathematics Department. He went to where he expected the office to be, and was relieved to discover that it was in exactly the same location as it was in his own universe. The interior, however, was much different. There were fewer desks against the walls of the small room, and a surfeit of posters on various mathematical subjects. He noticed that his favorite poster, on fractals, was missing.

He walked over to the location of his desk, at the back of the room, and hesitated. What if he ran into his other self here? He chided himself for not thinking ahead. He bent over the desk to see if anything on it or about it looked familiar, when he heard a voice from the doorway behind him.

"Who are you?"

Jack turned around, and was stunned. A woman carrying a briefcase stood in the office doorway, a woman who was the exact image of his old girlfriend Rachel Larsen. She had long, flowing blond hair, hazel eyes, and she stood a little shorter than Jack did. It took Jack a moment to find his voice. "Um—I'm Jack Levinson. I teach Math here."

She raised an eyebrow. "You do? I don't recall seeing you at any department meetings."

Well, that answered Jack's question about whether he might run into himself here.

Quickly, he said, "Um, I mean, I used to teach Math here. Once, a—a long time ago."

She closed the distance between them and studied his face. "Couldn't have been that long ago," she said, and smiled.

"Um—no, it wasn't. I mean, it was a few years."

She extended her hand. "I'm Paula Eisen. I teach Math here now."

Jack shook her hand carefully, constantly reminding himself that this was not Rachel. "It's a pleasure to meet you."

"Same here. Now could you tell me what you're doing here?"

Jack took a deep breath. "I'm looking for my friend Daniel Strock. He—he used to teach Math here with me." He reached into his pocket and passed the photograph over. She studied it for a few seconds, then handed it back with a shake of her head.

"Sorry. I don't recognize him. But this is only my first year here."

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"Um—right." Jack had been about to say that that shouldn't have mattered, but that would have contradicted the cover story he had just established.

"Would you excuse me, please? You're standing in front of my desk."

"Oh. Sorry." Jack moved to the side, and a sudden wave of dizziness hit him. The room spun and colored lights danced around Jack's field of vision. He fell to the floor.

"Hey! You OK?"

Jack recovered almost immediately, but stood up slowly, using her desk chair as a brace. "I'm fine, Ms. Eisen."

"Paula, please." She put her briefcase down on her desk. "It looked like you lost it for a moment there."

"Yeah, well, maybe I did. My apologies. I guess I should go."

Jack turned away from Paula, headed for the door, when she said, "I'm curious about something."

He turned around. "Um. Yes?"

"Don't you keep track of your friends?"

"It's kind of a long story." He shrugged.

"Uh-huh. Whatever you say." She paused, then said, "Listen, are you sure you're going to be all right?"

Jack nodded. "Yeah, I think so. I just need to figure out what to do next."

"What to do next?"

"I mean, to find my friend."

"Oh." She sat down and smiled. "Maybe I can help."

Suddenly Jack felt hope. "Really? How?"

"Well, I'm not sure. But if he did teach here, I suppose I could ask around, see if anyone remembers him. That is what you're doing, isn't it?"

"Sort of. But I can do this myself, thanks."

"Do you have permission to be in the building?"

Jack remained silent.

Paula sighed. "I thought not. Listen, why don't you go home, rest a bit, and I'll see what I can find out about your friend. Daniel Strock, is that what you said his name is?"

"Yes, that's right."

"Good. And in turn, you can take me out to dinner tonight."

It took Jack a moment to understand what she had just said. "Dinner?"

"Well, how else were you going to find out what I learned? You can pay me back for my help by telling me all about what the school was like when you taught here. I'm a sucker for local history." She smiled. "Want to pick me up at five?"

"Um, all I have is my bike."

She rolled her eyes. "Fine, I'll drive. Meet me in front of the school. And don't worry about your bike; we'll be able to lug it along."

Not being able to think of anywhere else to go, Jack spent the day at Sims Library, browsing through childhood books and trying to recover his composure. Paula Eisen seemed to be this universe's analog to his old girlfriend Rachel, which disoriented him a great deal. He had a lot of trouble imagining Rachel as a math teacher, as she had been more interested in other things and eventually went into the business world.

In a way, though,. that would help remind him that Paula was not Rachel, that this woman had an entirely different lifestyle, and perhaps even a radically different life history. At the very least, he had to remember that she did not share any sort of history with him.

At a few minutes before five o'clock, Jack waited in front of the school, his bicycle standing next to him. The street in front of the school was mostly deserted, which made sense, given that the school day had ended almost two hours ago.

Paula was right on time. She drove up fast in a red pickup truck, came to a screeching halt, and jumped out. No, thought Jack, she was definitely not like the Rachel he knew. Paula seemed much more impulsive, much more of a

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risk-taker. Why else would she have arranged to go out to dinner with a total stranger?

"Hello," Jack said.

"Greetings. Let's get your bike into the back." The two of them lifted it into the truck, then got in themselves.

"Where are we going?" Jack asked as they pulled out.

"I figured we'd head to Dallas. There's an Italian restaurant I like, if you have no objection."

"No, Italian sounds fine."

"Good. Do you mind if I put on the news? There aren't enough hours in the day to keep up."

"Sure, go ahead."

Paula turned the radio to a news station, and Jack listened intently to get an idea of how different this universe was from his own. To begin with, he didn't remember this particular station broadcasting news back home, but he didn't say anything. Oddly enough, the news didn't sound too out of place. The name of the president was the same, and the international stories seemed logical, as far as Jack could tell. But then they got to local news, and Jack leaned forward.

"Ellis County police are still looking for a man who trespassed onto the Superconducting Supercollider facility late last night and wandered off. Although they report no vandalism or any damage to the collider, police say that the trespasser should be considered dangerous and that if anyone—"

Jack turned the dial, cutting off the announcer in the middle of his sentence. The radio cut into the middle of a country and western song.

"Hey! What'd you do that for?"

"Sorry. I just got into the mood for some music."

"Well, switch it back, please."

Jack took his time doing so, and by the time he got back to the news station, the announcer was on a different story.

Jack spent the rest of the ride silently contemplating his fugitive status.

They arrived at the restaurant ten minutes later. It was one of those that hovered between casual and formal. Red tablecloths, large mirrors and the windows facing the road contrasted with classy finished wood furniture and somber prints hanging on the walls. Paula and Jack were shown to a small corner table upon which sat a lit candle in a glass, superfluous given the bright lighting.

They ordered dinner. Paula requested a simple plate of spaghetti. Jack felt starved and asked for a lasagna, all the time worrying about how they would pay for the food at the end. He hoped Paula had money.

Once the waitress was gone, Paula began the conversation. Jack desperately wanted to hear if she had found out anything about Daniel, but instead she started by quizzing him on the history of the school. She asked questions about people, courses, and the school grounds. Jack did his best to keep up with logical answers, but hesitated over a lot of what he said. Finally, she laughed and said, "You don't really know much about the school, do you?"

"What do you mean?"

"I mean, Mr. I-taught-here-before, that your knowledge of Waxahachie High is lame at best. You've been answering questions about teachers who never existed, for one thing, and giving me nice complete stories about them. You haven't recognized the names of people you should have known had you actually taught there." Paula leaned forward. "And, finally, the name of your friend Daniel Strock drew a complete blank as far as the Ellis County school system was concerned. No one by that name ever taught in any of the schools in Waxahachie." She leaned back again. "Just who are you, really? What's your story?"

Jack took a deep breath. "You wouldn't believe me if I told you."

"Try me."

Jack looked around. "Well, for

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starters, I'm not really from here. Sort of. I mean, I am and I'm not."

"Ah. A paradox."

Jack changed tactics. "What do you know about the SSC?"

"The collider? Not much. It brought a lot of money into Waxahachie when they decided to build it, but I wasn't around then."

"Do you know anything about what happened with the collider two years ago?"

"You mean when they almost closed it? Yeah, the experiment wasn't working for a while, and then they got it to work again. Why? Do you work there?"

Jack shook his head. "Do the names 'Universe One' or 'Universe Two' mean anything to you?"

Now Paula shook her head. "No, should they?"

It became clear to Jack that the federal government of Universe Beta must have kept quiet the events of two years past. Well, he thought bitterly, they could get away with it more easily. It wasn't as if anyone had died in this universe.

At that moment, the waitress came to their table with their dinner. She set the plates down in front of them, and they began eating. Jack dived in, and with the first swallow his hunger intensified. He hadn't realized that he was so ravenous, but that made sense, given that he hadn't eaten since yesterday.

"Slow down, pardner! It's not going to run away from you."

Jack swallowed another mouthful, and gave Paula a sheepish grin. "Sorry. You were right; this is a great place."

"Thanks. It's not too expensive, either, another reason why I like to come here."

Jack paused with his fork in the food. "Um. That's something else. I may need *your help paying for dinner. But I* promise to pay you back." Somehow, he added silently.

She rolled her eyes. "Don't tell me; let me guess. You don't have any money on you."

"No, I do, it's just that—well, let me show you." He took out a dollar bill and passed it over to Paula, who glanced at it and gave it back.

"Looks fine to me."

"It does? I mean, could I see one of your dollars?" Back at the motel, after that initial wave of dizziness, Jack had frightened himself so much about the possibility that his money wouldn't be good here, that he had forgotten to check it out.

She shook her head, but took her wallet out of her purse. "You're really weird, you know that?" She handed over a bill and Jack compared it to his own.

There were no discernable differences. It was possible that Jack's money would show up as counterfeit under greater scrutiny, but for routine spending, it would suffice. Too bad he hadn't known about that last night. He could have slept in comfort, taken a shower, and eaten lunch.

"Looks like my money's good here after all," he murmured, and handed Paula's dollar back.

"So you can pay for dinner?"

"Uh, yeah, sure, I guess. I just didn't expect to be able to."

"Which brings me back to my question. What's your story?"

Jack stared over Paula's shoulder. "I'm not from this Earth."

She laughed. "Don't tell me you're from outer space!"

"No—no. It's not like that. I'm—I'm a visitor from Universe Alpha. I mean, Universe Two."

"Ah. And that's supposed to make it all clear to me, right?"

Jack knew this sounded crazy, but he kept going. "Look, the reason the SSC stopped working was because the beams leaked into another universe, mine. Maybe that didn't make the news around here, but it definitely made the news in my Waxahachie. There was an explosion. It killed my friend Daniel, and . . ."

"And now you've come here to see if you can find another version of him."

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"Right."

She smiled. "Thanks for trying. Want to play again?"

"You asked. I'm serious."

"Are you? That's one of the silliest stories I ever heard."

"It's true. And I really could use your help." He thought a moment, then let out a sudden burst of laughter. "I just realized—this is 'The Search for Strock!'"

"Huh?"

"We're even eating in an Italian restaurant, me and the native. Oh, no, wait, that was the next movie."

"Jack, what are you talking about?"

"It's a pun. You know, on *The Search for Spock*?"

"Spock? You mean Dr. Benjamin Spock, the pediatrician?"

"No, I mean Spock, Kirk's first officer."

"Huh?"

"On TV. Haven't you ever seen *Star Trek*?"

Paula shrugged. "Never heard of it."

Another divergence between universes. Jack really had to stop making these assumptions. But wait a minute—

"Paula, I just mentioned a TV show to you that apparently doesn't exist here. Now do you believe me?"

She ate a little more food before answering. "You could be making that stuff up, just to make your story more believable. I'm sorry, but you're going to have to come up with something better than that."

Suddenly, Jack felt the same wave of dizziness he had felt that morning. He doubled over, his arms gripping his body tight.

"Jack? Jack! What's happening?"

The universe faded away around him. He was in quiet darkness for an indeterminate time.

Suddenly, he was back in the restaurant, sitting across from Paula. He felt weak.

"Jack! Are you OK? You—you flickered out for a moment there."

He nodded and looked around. A few of the other diners were staring in his direction. "We'd better get out of here," he whispered.

"You got that right." Paula left money for their dinners and helped Jack to his feet. As they headed towards the exit, she said, "Oh, Jack."

"Hm?"

"I think I believe you now."

Paula lived in a small apartment in an old Victorian house that had been split up into individual units. It was a third floor walkup, but Jack felt well enough by the time they got there to climb the stairs without help.

Paula opened the door and turned on the lights, revealing a living room a little more cluttered than Jack's own. "Have a seat," she said, pointing him towards a blue sofa. "I have to go to the bathroom. Be back in a minute."

Jack chose to wander around the room instead. Whenever he visited a friend, he always felt drawn to see what books were on the shelves, and the same urge existed even here. Paula kept her bookcase next to her television set, and Jack noticed that videotapes and CDs crammed for space among the books. Her tastes were eclectic. She had a lot of mathematics books, of course, but there were also quite a few popularizations of science, and a whole shelf devoted to comparative religion. No books on economics, though, which seemed odd, given Rachel's interests back home. Paula's fiction tastes also diverged from Rachel's. Rachel liked romances; Paula's novels ranged from mysteries to fantasy, and Jack noticed a preponderance of titles by authors with the names of Ardai and Pierce. Idly, Jack wondered how many of these titles were unique to this universe. He picked up a science fiction novel titled *Infonaut* and began paging through it. It didn't look like anything he remembered from back home, and he suppressed an impulse to steal the book.

Paula emerged from the bathroom while Jack still had the book in his hand.

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She had changed into shorts and a T-shirt. "Can I get you anything?"

"No thanks," he said, returning the book to the shelf. "Interesting collection you have here."

"Thanks." She walked over to the TV and turned it on, but kept the sound low. "News," she said, as she sat down on one end of the sofa. She grabbed a pillow and pulled her legs up. "I hope you don't mind."

"Not at all." Jack said. He settled himself comfortably onto the other side of the sofa. They remained silent for a few seconds. The flickering of the television screen and its low droning dominated the room.

Finally, Paula spoke. "So. Feeling better?"

"Yeah. Thanks."

"Good. Now, Jack. You must have extreme loyalty towards your friend to come to another universe to find him!"

He chuckled. "I guess so."

"Want to tell me the full story? I think I'm ready for it now."

Jack nodded, and in a few minutes, it seemed, he had told her his whole life story. When he finished, she wrung her hands for a few seconds and stared at the television. Then she turned back to look at him.

"Don't you realize how illogical this is?"

Jack squirmed. "Well, sort of."

She rolled her eyes. "'Sort of,' the man says. Jack, I'm sure you've thought of this already, but I think you need to hear this again. Brace yourself.

"*If Daniel Strock does exist in this universe, he's not your Daniel Strock.*"

Jack looked away from her. "I knew that."

"Oh, did you? What were you planning to do? Introduce yourself as the long-lost best friend he never had?"

"Well, I—"

"And have you considered the possibility that he doesn't exist here at all?"

"What are you talking about?"

"You yourself said that there were different scientists working at the two different laboratories. How do you know that a version of your friend exists here?"

Jack shouted. "He must exist here! *You* exist here!"

"So?"

"Listen, Rachel—"

"*Rachel?*"

He felt his face flush. "I mean, Paula."

She raised an eyebrow. "Who the hell is Rachel?"

"Rachel is—was—I mean—Rachel's an old girlfriend of mine. Married now."

Jack swallowed. Paula sat silent for a moment. Then she jumped up and threw the pillow at him, hard.

"Was this a ploy—" she yelled.

"No!" Jack replied. "I swear! I didn't even know you were here! If I had been looking for you, I would've brought a picture of you, not Daniel!"

That seemed to calm her down. She sat down again, but faced away from Jack and towards the television. Suddenly she seemed surprised. She leaned forward, grabbed the remote control, and turned up the volume.

Jack looked towards the television. There was a picture of him to the upper right of the news anchor. The anchor was saying, "—still looking for Jack Levinson, who trespassed onto the SSC facility today. Levinson should be considered dangerous, and if you see him, do not approach him yourself. Instead, police are requesting that anyone with information call them at the number on your screen."

The anchor went on to another story, and Paula muted the sound.

"You're hot, aren't you?" she asked softly.

Jack nodded. "It's what I told you. Dr. Zahn said that they couldn't send too much mass through the Gate, or else—"

Another sudden spell of dizziness overcame Jack and the world turned dark and quiet. When the world came back, Jack saw Paula running around the room frantically.

"Are you all right?" she asked him after

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she spotted him. She sat down next to him and put her hands on his shoulders.

Jack nodded; this time, he felt weak and his throat felt dry. "I could use some water," he croaked.

Paula nodded and brought him a glass from the kitchen, which he drained eagerly. "What happened?" he asked.

"You were gone for a full minute. For a moment there, I thought—" She stopped.

"Yes?"

"Nothing. I'm glad you're OK."

"Thanks."

Paula sat down again. "All right, Jack. Look at this optimistically. Let's suppose Daniel did exist here and was willing to be your friend. How were you going to stay in touch? What were you planning to do? Live here indefinitely? When you keep vanishing like that?"

"I—I don't know. I guess I hadn't given it much thought."

She laughed; her eyes sparkled. "Ain't that the truth." After a moment, her face took on a more somber expression. "You know what you have to do, Jack." She tilted her head towards the television, reminding Jack of the news report. "Tomorrow, you have to call the lab and tell them where you are. Otherwise . . ."

He nodded. "Otherwise, I might disappear completely."

"Yeah. And—and I wouldn't want that to happen."

They were silent for a moment, then Jack said, "Let's talk about something else."

"OK."

They talked about books, about childhood, about current events. They delighted in both the similarities and the differences between their two universes. The night grew longer, and they found themselves moving closer together on the sofa. Finally, Jack's arm went over Paula's shoulders, and she pulled him close.

They began kissing, first warmly, like close friends, then passionately, like lovers. Jack felt the warm sensuousness of her body next to his, and knew he wanted her and that his desire was reciprocated. But . . . but he also knew it wouldn't be right, as he was sure she realized as well.

They broke off the kiss and gazed at each other for a few seconds, although it seemed like much longer. Then he spoke. "I'll sleep out here."

She hesitated, then nodded. "I'll get you a blanket." She opened a closet, pulled one out, and handed it over to Jack.

"Thanks," he said, taking the blanket.

"Good night."

"Night."

Paula closed the door to her bedroom, and Jack lay down on the sofa. It took him a long time to get to sleep.

The next morning, Jack woke to the sound of Paula on the telephone. "Hello? Yes, this is Paula Eisen. I won't be able to come to work today. Could you ask Maxine to make sure my classes are covered? I've left emergency lesson plans in the top drawer of my desk. Thanks."

Jack groaned, and Paula turned to him. "Good morning."

"Ugh." He sat up, rubbed his eyes. "What time is it?"

"Seven. I had to call in sick."

"Seven," Jack echoed. "You know, the one thing I could never get used to in our profession is the early hours."

"Oh, you ought to be used to it by now." She headed towards the kitchen. "Want breakfast?"

"Sure. Just let me get ready."

"Fine. I've left a fresh razor on the bathroom sink for you. You probably want to shave."

Jack got up and headed to the bathroom to take a shower. Half an hour later, dressed in the same clothing from yesterday and the night before, he joined Paula at her kitchen table. She was eating cereal and scrambled eggs, and reading a newspaper.

"Good morning."

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"Good morning." She took a sip of coffee. "Feeling more human?"

"Yeah, I think so."

"Good. Help yourself to some food. There are eggs on the stove."

Jack filled a plate with eggs and a bowl with cereal, but demurred at the coffee, as he never drank the stuff. He poured himself some orange juice instead, sat down, and asked, "Can I have the comics?"

"Hm." Paula turned a page. "You'd probably rather take a look at this." She handed him the main section of the paper, folded over to an article titled, POLICE SEARCH FOR SSC TRESPASSER." The same picture of Jack from last night's news broadcast accompanied the article.

Jack handed it back. "I doubt there's anything new from last night."

"No, but they did interview some lab bigwig. Dr. Anderson, I think her name was. It sounds like she's the one you're going to have to call."

"Anderson . . . yeah, I remember her. She was present when the universes merged." He started to scan the article. "What's it say she does?"

"It calls her a project leader, but doesn't say which project."

Jack swallowed some eggs. "Given the lid your side is keeping on the existence of my universe, she's probably the one in charge of the Gate on this end."

Paula nodded and sipped some more coffee. "So what's the plan?"

"The plan is—" Again, Jack felt dizzy and his world disappeared. When it reappeared, Paula's place at the table had been cleaned up. She sat there, her face obscured by her newspaper.

"How long?" Jack asked, feeling weak and parched. He reached for a glass of orange juice and drained it.

Paula peered over her paper and checked her watch. "Forty minutes."

"You seem awfully casual about this."

She shrugged. "What could I have done? I figured if you didn't reappear all day, I'd call the lab. About the only other thing I did was make sure not to sit in your chair."

They both smiled at that, and then Paula added, "But I was worried, in case you were wondering."

Jack finished eating while the two of them engaged in idle chatter. After he was done, Paula cleared his plates, sat down again, and said, "So."

"So."

"Do you want to call them now?"

Jack nodded. "But not from here. If they've been keeping the Gate a secret, I don't want them to be able to trace you to me. You might get in trouble."

Paula laughed. "Oh, so the big man is going to protect me from danger! Save me, save me!"

Jack sighed. "I was being serious."

"So was I. Jack, I want to help you with this. But I can't if you don't let them know about me. Otherwise, there's no way they'd let me in to communicate with you. And if I'm going to search for Daniel for you—"

He interrupted her. "But I thought—" Then he stopped.

"You thought what?"

Jack felt uncomfortable, and he shifted in his seat. "Well, from what you said last night, I thought you didn't think I should bother looking for Daniel anymore. I didn't realize you were volunteering to help me find him."

"So what did you think I wanted you to call the lab for?"

"Um, well, after you pointed out that I may not be able to stay here indefinitely, I was going to see if they had a way of—of stabilizing me, so I wouldn't keep disappearing, and so I could keep looking."

She shook her head. "Jack, I really don't think that's the way to go about it. But if that's how you want to play the game, we'll play it your way."

Paula drove them to a pay phone a few blocks away, and waited in the air-conditioned cab of her truck while Jack stood in the heat and light of the late morning. He dialed the lab and asked to be connected with Dr. Anderson.

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"Who is this, please?" the voice on the other end asked.

Jack paused, then gave his name.

There was an immediate click, and Dr. Anderson came on the line. Jack recognized her voice from two years ago. "Mr. Levinson! Thank God! Where are you?"

Jack didn't want to be rude, but the phone call had to be on his terms. "Never mind that," he said. "We need to talk."

"Mr. Levinson, you need to get back over here right away. We—"

"No. Dr. Anderson, I'm not coming back."

There was a pause. "You don't understand. You passed through the Gate at a crucial time of operation. Ever since you jumped over, the Gate has been going haywire. We've been trying to restabilize it, but it doesn't want to cooperate. If you don't come back, we may lose it entirely."

"Dr. Anderson, quite honestly, I don't care about the problems you're having with your experiment. I've been having problems of my own."

"I can imagine. Listen to me. You don't belong in this universe. If the two universes get separated, your home universe is going to try to drag you back into it. But without a working Gate, we don't know where you'll be dragged to. Probably some nonexistent in-between."

Jack swallowed hard. "I think I've already experienced it. And that's my problem. I need to stay here in your universe for a while."

He could almost hear her shake her head. "That's not possible."

"Oh, come on! You must have some way to allow me to stay here for an extended period of time. Maybe we can cut a deal."

"A deal? Mr. Levinson, you can't cut a deal with the laws of physics. It's not safe for you to stay here, and we don't know how to make it safe."

"Look, I know people have gone through before—"

"What? Who told you that?" Dr. Anderson sounded stunned.

"Um, one of the technicians on the other side. He said that he'd been through many times."

Dr. Anderson laughed, a frank laugh that bore no traces of deception. "He was kidding you. The Gate is *dangerous*, Mr. Levinson. We wouldn't let people go through casually. In fact, you're the first. The only things we pass through the Gate on a regular basis are radio waves. That's how we communicate with the other side. We—we don't want to set off another explosion." There was a pause. "I never got a chance to tell you how sorry I was, about your friend."

Suddenly Jack realized that Anderson felt real guilt over Daniel's death. Not just guilt, but responsibility as well. It had been her collider, after all, which had leaked its antimatter beams into his universe.

"Thank you," he said.

"Jack, listen," she said, using his first name for the first time. "We're just beginning to understand the Gate. If you come back and go home, we may be able to figure out how to allow safe passage for an extended period of time. But if you insist on staying here, you risk hurting not just the experiment, but yourself and the two universes as well. Please come back. I promise that no harm will come to you, and you'll be able to pass freely back into Universe Two."

"I'll call you back," Jack said, and hung up the phone.

They drove back to Paula's apartment in silence, as Jack wanted time to assimilate the conversation. Once they were seated upon the sofa, Jack summarized the phone call for Paula.

"You're going to have to go back," Paula said when he was finished.

"I guess so."

"You *guess* so? Jack, if you don't go back, you'll eventually disappear for good."

"Yeah, I know. But it still feels wrong."

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"It's not that bad, Jack."

"Yes, it is. I—I really needed to find Daniel."

"Why?" Paula said sharply.

"Huh?"

"'Why?' I asked. Why was it so important for you to find Daniel?"

"Because he's my friend. I thought I explained that."

"Jack, there's got to be more to it than that. People lose their friends all the time. But life goes on."

"It didn't for Daniel."

"Well, it doesn't seem to have gone on for you either." Jack winced, and Paula said, "Sorry. But it is true. Isn't it?"

Slowly, Jack began to nod. "It's true." He looked around the room for a moment, and let his gaze settle on the bookcase. "I—I feel old. I keep thinking I should still be a high school senior, or that I've just graduated from college, when it's really been over five years. I have this mental image of myself that I know intellectually is untrue, but I can't shake it. Every time I realize where I really am, how old I really am, I get scared."

"You're too young for that. We both are."

"I can't help the way I feel."

Paula shook her head. "You know what your problem is? You never faced death before."

"That's not true. I had a pet mouse once who died." Even as he said it, Jack realized how silly it sounded.

"Do you really think that's the same?" She put her hand on Jack's shoulder. "My father died when I was a senior in college. About seven years ago."

Jack turned back to look at her. "Oh. I'm sorry."

"Thanks. And I have to admit, if I knew that he still might exist, somewhere, I might have gone looking for him, just like you did. But I didn't have that option. No one really does. So I got on with my life."

She paused momentarily, then continued. "Jack, like the rest of us, you didn't want to deal with it, you didn't want to accept it. That's OK. But unlike the rest of the world, you had a rather bizarre way of not dealing with it. You were able to hold onto a strange hope that no one else would ever have thought of. You went looking for your friend in, God help us, another universe."

"But I didn't find him."

"But we still may. Look, I'll take you to the lab. We'll let them know I'm searching for Daniel on your behalf."

"You'll keep looking for him?"

She nodded. "I will. We'll get those stuffy scientists to help out, or else I'll threaten to tell someone. I'm sure they'll let us stay in touch, so I can keep you informed." She smiled, and they stood up. They stared at each other for a moment, then embraced and kissed.

After they had disengaged, Paula said, "Jack, from what you told me, Daniel was an impulsive, fun-loving person, right?"

"Yeah, he was."

"Well, he would have loved what you did these past few days."

Jack flashed a grin. "He would have, wouldn't he?"

Paula nodded. "And not just because, in your own way, you were trying to rescue him. But because of the way you did it."

"I guess Daniel's not that far away from me after all."

"No, he's not."

"But, if you do ever find him—"

"I'll let you know."

As they headed out her apartment door, Jack said, "Don't let me forget my bike," and he smiled.

She smiled back. "Don't worry, I won't."

Jack returned to his home Universe that afternoon.

Jack checked the address on the envelope against the number on the frame of the house as he wiped the sweat off his forehead. Summer in New York City was always the worst. He still found it difficult to believe that he was here, on 75th

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Road in Forest Hills, Queens, but that's what the street signs said.

The house seemed to be the correct one. He climbed the steps and rang the bell. In a moment, the door opened, and there was Rachel, holding a baby in the crook of her left arm. She looked puzzled for a moment, then her face lit up.

"Oh my God! Jack! Is it really you?"

Jack nodded. "Yes, it's me."

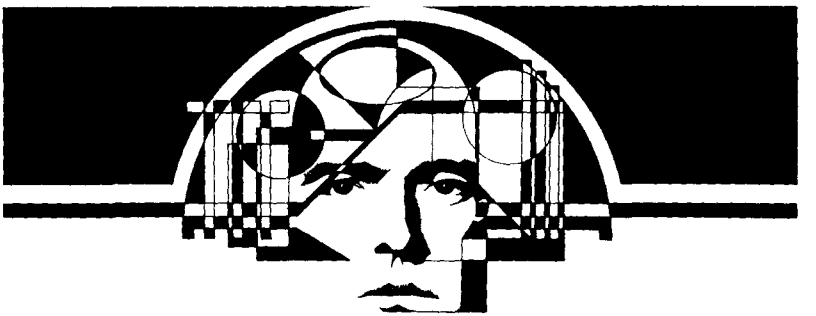
"It's great to see you! Come in, come in!"

Jack entered the house and looked around. The door opened onto a living room, in which sat a large piano, a sofa, and a desk. On either side of the desk were bookshelves, set into the walls, and Jack spotted their old high school yearbook sitting on one of the shelves.

"Why didn't you call me to tell me you'd be coming to visit? What's up with your life? What's going on?"

Jack looked around, and he felt the picture of Daniel in his pocket. "I'm back," he said. "I'm finally back."■

(Editor's Note: "Absent Friends" is a sequel to "Broken Symmetry," February 1997.)



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Chat with Hugo-nominated author, **Paul Levinson**, Wednesday, July 22 at nine P.M. (EST)

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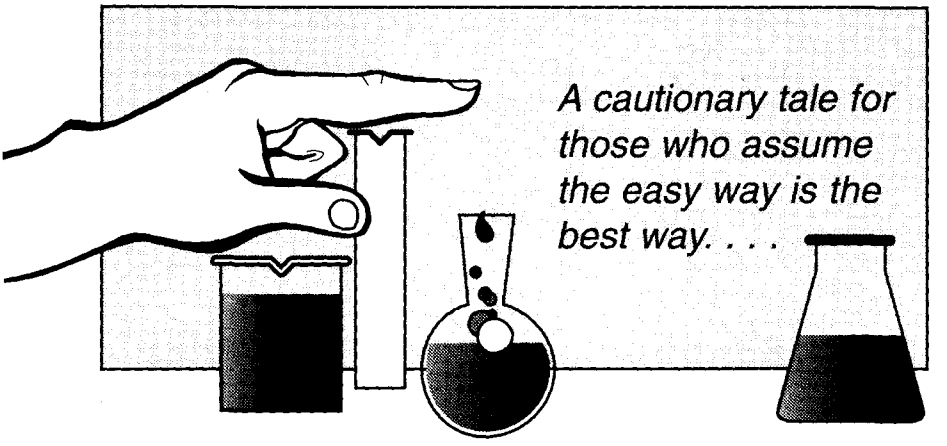
Charles L. Harness

The Downsizing of Dr. Jain



A cautionary tale for those who assume the easy way is the best way. . . .

The grid was a tray containing 1,089 small glass cups, 33 on a side. Each cup contained soil and a fingernail-size plastic chip. The chip was stuck halfway into the soil substrate.

Dr. Jain surveyed the assembly with melancholy disinterest. He had prepared the grid one week ago, using soil taken from the local county landfill. Which is to say, the dump. A variety of chemicals had been added to some of the cups. The untreated containers served as controls.

Dr. Jain was thinking mixed thoughts. His foremost thought was his forthcoming session with Dr. Nyrock, Chief of Organics, and his immediate supervisor. He was fairly certain Nyrock was about to fire him.

Lesser thoughts involved his current project, an attempt to biodegrade plastic scrap. We produce millions of tons of the stuff (he was thinking). It's against the law to burn it. It doesn't degrade in land fills. It is eternal. We make more and more of it, and it accumulates, builds up, just keeps growing. Only a fraction is recycled. We're converting all our gas and oil and air into junk that must eventually smother us. Wheat, chickens, cows, tomatoes, we eat, and they disappear. Not plastics. We bury iron, and it dissolves like sugar. Wood, paper, cellulose quickly carbonize in the ground. Raw vegetation turns to compost practically overnight. Plastics just sit there.

He sighed. The project must fail. As he had known it would. Project BD—biodegradation. After one week, not one of the more than a thousand chips had degraded. If the run proved anything (he thought), it proved that all plastics are inert under all conditions. No surprise, really. Nyrock probably had assigned the project to him because it was sure to fail.

And probably his swan song.

Rather idly he picked the translucent polypropylene chip from a corner cup, examined it briefly, then replaced it. No apparent change. The technician would come in the morning and remove all the chips and weigh them. She would find

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no differences in weight, appearance, anything, and that would be the end of the run, the end of the project, and the end of him.

He looked up at the wall clock. Four P.M. He was due in Nyrock's office in thirty minutes.

He jerked. Had he taken his insulin shot? No. Small wonder. Chaotic schedule. Everything out of sync. He went over to the lab refrigerator, got his insulin vial, rolled it between his palms to stir up the colloids. If he were fired, he'd have to remember to pack it in ice, take it along with the books and desk detritus. Synthetic insulin. A beautiful piece of genetic engineering. They implanted the human insulin gene in a bacterium, and the little microorganism faithfully did the rest. It had lived because it was useful. He was useful, and he was dead. He should have been born a bug.

He returned to his desk for a syringe. He removed the sterile cap, fumbled, accidentally hit a vein in his arm, and was about to withdraw the needle and try a centimeter away, when he stopped, because he realized he was having a very remarkable idea.

Enzymes . . . ?

He drew out a cc of blood and emptied it into the corner cup in the grid. He tossed the syringe into the sharps can, checked the wall clock. He couldn't stay around and watch, but he'd be back. At the door he turned for a last look at his desk. A stranger would probably be sitting there before the week was out: some smart savvy high-tech brand new young doc at half the salary and no pension worries. Downsizing . . . done in by downsizing.

Time now to report to the chopping block. Bad form to keep the executioner waiting. He closed his eyes briefly and started down the corridor.

"Don," Dr. Nyrock said matter-of-factly, "I'll give it to straight. We'd like for you to take early retirement. You've been with us a long time, and your severance package will be generous."

"What if I don't want to take early retirement?"

Nyrock shrugged. "You know the answer to that. You'll be terminated for cause."

"On the day before my pension vests."

"If it comes to that."

"'For cause.' *What* cause, Rocky?"

"Cause?" The group leader thought for a moment, then he got up, came around the desk, and stuck his forefinger in the chemist's chest. "You've always wanted my job, Donald. And a couple of times maybe you came close. You've certainly had a string of successes. But now management tells me I've got to terminate one senior chemist. So I pick you, Donald. That enough cause for you?"

No answer.

Nyrock snorted, returned to his chair. "Look . . . I don't care whether you take the deal or not. Actually, if you don't, we save money, maybe increase my Christmas bonus. Suit yourself." He pushed the packet and a ball-point toward the destroyed man. "Sign at the X. Keep a copy."

Dr. Jain hesitated five seconds, clenched his fingers couple of times to stop the trembling, then signed.

"Good. Now, Donald, we'd like for you to clean out your desk promptly, turn in your records, keys, that sort of thing. Be out by noon tomorrow."

Dr. Jain gathered up his severance package. He understood the thinking. In a way it was humane. Clear out the corpses quickly . . . they're a mental hazard to the survivors. He said softly, "I have a run going in the hood. Can I wind it up?"

"Whatever . . . just be out by noon tomorrow."

On his way back to the lab, he was thinking. Well, he couldn't complain that he had been surprised. He had foreseen it all. The rules for downsizing were ironclad, like the rules for writing

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a sonnet or for dancing the minuet. Nyrock had merely done as he was told. He had followed the rules, step by step, except maybe for that last part where he had become insulting. No need for that.

He realized that downsizing had nothing to do with the economic health of the corporation. In fact, the healthier the company, the more likely it would get downsized. It was the fashion. And that's the way it had happened here. First the tobacco consortium, majority shareholder, had elected Paul (Stogie) Stokeley as CEO, and then Stokeley had brought in the hatchets. Bright young men came in big shiny black limos like the stretch broughams leading a funeral procession. They examined the rosters. They looked at ages and salaries. They picked Group A—senior high-salaried employees on the verge of pension-vesting. *He*, Donald Jain, was a statistic in Group A. Then Group B—several younger people, pretty much at random, to show no age discrimination, in case of litigation. Then, case by case, but quickly—the terminations.

Theoretically, tremendous amounts of money were saved. Productivity and sales might dip a little at first, but were predicted to recover soon.

Dr. Jain opened the door and walked into the lab.

How did he feel? He felt—odd.

There was some sort of paradox at work here. He had left the bay in fear, short of breath, heart racing. Those present had watched him go, a zombie, the condemned man walking down that last mile.

But returning . . . he felt somehow relieved. The bad part was over. Now to wind up and get out of here.

It was the tail-end of the work day. Everybody had gone. His mouth twisted in a half-smile. They didn't want to stay and view the cadaver. They had even turned off the lights. A bit premature, aren't we, fellows?

He snapped the lights back on and rather briskly walked over to the hood.

He studied the polypropylene chip in the cup where he had added the blood. It looked different. Well, well . . . he flicked away the grains of soil, washed the chip in distilled water, dried it in blotting paper, and took it to the scale. Simple matter to check it against starting weight in the log.

Yes. It had lost weight—eight milligrams. Wow! Far too much for experimental error.

He got his heartbeat under control, then sat down on a lab stool to consider this. It was the blood, of course. Almost certainly an enzyme in the plasma. As hoped for, but still a bit of a surprise. He'd identify the little beast later. Well, maybe not he . . . but somebody would. On the other hand, why should he care? He didn't, not really, except it was his run, and he knew something very important had happened, and that he, Don Jain, had brought it about.

Query, what does polypropylene degrade to? Let's find out.

He added two hundred cc of polypropylene beads to a lab mixer, followed by the blooded contents of Cup 1,089. He watched the little spheres pick up the stain. He emptied the treated beads into a glass column and set it up in the hood. Overhead he fixed a timed water drip. Under the column he placed a beaker to catch any liquid that came through. Next to this he arranged an identical setup, except that the beads were untreated.

He snapped Polaroids for his lab notebook and brought up the closed circuit TV camera.

And, he thought, I will feel very silly if this doesn't work. But here goes. He looked up at the wall clock. Approaching nine P.M. Save for the watchman making his rounds, he was totally alone. Fine with him.

He turned the water drips on, both at three cc per hour. Before the hour was out things began to happen. Under both columns something was dripping into the collection beakers. He sniffed, then tasted the liquid in the control beaker.

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Plain water, as expected. Now, for the treated column. Another sniff, another taste. Golly! Pinacol? Highly characteristic odor. Yes. Normally a crystalline solid, but evidently dissolved here in a liquid mix of its cousins and uncles and aunts. Mostly dihydric alcohols? Reasonable. Enzyme splits the polymer chain into three, six, nine-carbon segments. Three gives propane diol, six gives pinacol, nine gives nonane diol. And maybe even higher mono and di-alkanols, normally solids, but maybe dissolved here like pinacol.

These were exothermic oxidation products. In effect, he was burning the polymer, and he was probably generating heat. Should he cool the column? He felt the glass. It was warm. Have to watch that. Determine optimum operating temperature. Determine a lot of things. Not me, but somebody. His blood. An enzyme, obviously. Find it. That's all that's needed. All the rest . . . plasma . . . cells . . . waste products . . . superfluous. A real can of worms. No! A gold mine! Diamond mine! Project saved. Job saved? Job? What job? And who cares?

Donald Jain lifted his eyes to heaven. Thank you, thank you. The fates were finally with him. Did he dare look ahead? ACS chemist of the year? The savior of one hundred thousand landfills all over the world? And that's just for starters. Next, sieve out the plastic scrap, let the Jain process convert it all to useful oxygenated carbon compounds. Big money!

Yeah, but money for *whom*? He frowned. Got to give this a lot of thought. He looked about the bay. It was dark, empty, silent. Like a temple, he thought. There were tiny noises . . . residues of sounds left over from the day. Perhaps a few barely audible vibrations from the distant highway. But by and large—silence. It was all his.

Back to the hood. Next?

Polystyrene . . . coffee cups . . . molded shipping shapes . . . the bane of landfills.

Half an hour later, after another blood draw, he filled a third column with blood-treated polystyrene "popcorn". Within the hour he was rewarded. Drops of sparkling liquid began falling into the collection beaker. He could smell it from where he sat, and he grinned happily. *Benzaldehyde.* He did the equations in his head. The polymer depolymerized, giving the original styrene molecule—vinyl benzene—which then, under the insistence of his enzyme, oxidized smoothly to benzaldehyde. A beautiful smell, like almond oil.

Still another column? Well, why not? Acrylates. Already preoxygenated, should be a snap. And now about some of the nitrogens? Polyamides . . . polyurethanes . . . nylons. Might get a little byproduct HCN. Better turn on the hood fan. By seven A.M. he had five columns up and running, besides the control, and his multi-punctured arm was beginning to ache.

Time to sit down and complete his notes. And finish cleaning out his desk. The lab had kindly given him a couple of corrugated boxes. He had already filled one with books.

But first, the record.

He was still writing in his lab notebook when the first technician came in at eight-thirty. She seemed surprised to see him, but shrugged and headed for the coffee stand.

The fun began a little after nine, when the professionals began arriving. They all reacted pretty much the same. First, they took note that Jain was there. They nodded, mumbled something, didn't meet his eyes. Secondly, after they put together their coffee or tea or cola, they noted the hood was open and the fan going. They sauntered over, read the labels in front of the glass columns, and then ultimately and reluctantly approached (not too close!) the leper.

"Don—what the hell? Is it real?"

"It's real."

At ten Dr. Nyrock came down. He inspected the columns. He talked to the

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chemists clustered at the hood. Heads kept turning back covertly to look at Jain. Sometimes he caught an eye and grinned. The heads jerked back.

Another five minutes . . . yes, here came Nyrock. He had some kind of genial expression on his face. Not a smile, exactly, and anyhow he couldn't hold it, and his face was back to normal by the time he reached Jain's desk. "Is it real?" he blurted. "The plastics oxidize to alcohols . . . Aldehydes?"

"Yes."

"Reproducible?"

"Yes."

"Well . . . Donald . . . I don't really know what to say."

"You don't need to say anything, Rocky. I followed the procedure. I wrote it up in detail." He handed the group leader his lab notebook. "You can witness and date the page yourself. Also, you'll have the Polaroid and video records. I guess that wraps it up? I'm due out of here by twelve, guess I'd better be on my way." He picked up the box of books.

"But . . ."

Dr. Jain was through the door and gone.

They were meeting in the second floor conference room, where the oak table was just the right size for five people. Axel Kursh, Vice-President, Research—"Veep-R", had come down from the seventh floor. "Gentlemen, madam," he said softly, "Marketing International tells me this BD invention may be worth several billions, worldwide, over the life of the patents. If you can make it work. Rocky, bring us up to date."

Dr. Nyrock took a deep breath. He knew he had but followed instructions in terminating Jain. He also knew it might well appear the act was poorly timed. Stupid, even. But how was he to know?

"Rocky?" whispered Veep-R.

"Yes. Well, a week ago Dr. Jain completed certain experiments demonstrating biodegradability of several types of plastics—polyolefins, styrene, acrylates, and so on. He used his own blood as a catalyst. In five columns of five different plastic chips, tap water plus the catalyst reacted successfully with the chips to provide a mix of familiar oxygenated products ranging from glycol to benzaldehyde. Dr. Jain provided a full written record in his lab notebook, and in addition we have photographs plus excellent TV coverage. So far as we can determine, he held nothing back."

"But you can't reproduce his results," Kursh said in a flat, non-accusing voice.

"That's true. So far, anyway. There's a difference, somewhere. We just don't know what it is."

"In the blood?"

"Maybe. First we tried cow blood from the slaughterhouse. No luck. Then human blood. Jain is Type A, so we tried that first. Then O, the universal donor type. No. He's a diabetic, so we tried various levels of insulin, with and without glucose. Nothing."

The group leader studied Kursh's face uneasily. "We now think it may be something specific, something quite rare. Something possibly found only in Jain's blood. Our bio department tells me there are in fact twenty-one known types of blood. We have tried sixteen or seventeen, with several very rare types still to come in from Africa and Asia. " He shrugged. "Dr. Rothkull is our consulting hematologist. Perhaps he can explain the problem a little better."

"Doctor?" said the vice-president.

The hematologist, a florid rotund man, frowned thoughtfully. "Well, Axe, I think we have to realize that blood is an organ, like our liver, or kidneys, or lungs. And it's like a highway, with all kinds of traffic. Blood plasma is ninety percent water, but it's loaded down with all kinds of goodies: glucose, lipids, vitamins, hormones, proteins, enzymes, metabolites, wastes. The major protein

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is albumin, which is there in sufficient concentration to prevent loss of water to surrounding cells. And of course it carries lots of red blood cells—billions per cc. And white blood cells, too—one or two per thousand RBC. And an array of dissolved ions that approximates sea water, which of course is where life arose: sodium, chloride, bicarbonate, calcium, magnesium, copper, potassium, zinc, a few others." He paused and looked around the table. "So, with all these variables, it's easy to see that everybody's blood differs slightly from everybody else's. Sort of like fingerprints, or DNA."

Kursh coughed softly and looked across the table at Nyrock.

"Doctor," the organics chief said hurriedly, "where does it all come out? What's the bottom line?"

"*Tentative* bottom line," corrected Rothkull genially. "We suspect Jain's blood contains an oxidative enzyme that is not present in any of the blood samples so far tested."

The vice-president looked thoughtful. "But how could Jain's blood be so different?"

"Different physiological history," said the blood expert. "Different childhood illnesses, with different immune response residues."

"Maybe I'm missing something here," observed Jones, of Marketing. "Jain used what—five cc's of his own blood? It contained this miraculous enzyme. What happened to the enzyme? Did it get used up?"

"Not in the sense you mean," said Rothkull. "The problem is half-life. Most enzymes just finally fade away."

"Doctor," whispered Kursh, "if you had a sample of Jain's blood, could you identify this hypothetical enzyme?"

"Probably. We'll need at least five cc. Get him in here. Let the nurse draw the sample."

The vice-president continued. "And Rocky, if we I.D. it, can you make it commercially?"

"Probably, but first we'll have to see what it is."

"Of course. Now then, Jain's under contract to assist us in patenting his inventions made in the course of employment and for a year thereafter, right, Rocky?"

"Yes. We all are."

Axel Kursh smiled faintly. "Anything unreasonable in asking him to donate five cc of blood in a patent matter? Anybody?"

Ms. M. Justin, Budget Forecasts, spoke in a low drawl. "We fire him on Monday, Tuesday we demand his blood?"

The leader chuckled. "Right on, Maxie. He'll tell us to go to hell. Still—"

"How high can we go?" asked Ms Justin. "I need the figure for the next quarter."

"A million," said Veep-R. "Rocky, you have his number, you place the call. Start low." He pushed his cell phone across the table.

The organics chief hid his distress nobly. "Now?"

"Now. We'll listen in on the speaker."

The call went through promptly, almost as though the ex-employee had been waiting for it.

"Hello, Don? Rocky here. How are you?"

"Nyrock? Well, well. You calling from the conference room?"

The caller sighed. "Yes, Don. We're all here, listening."

"Come to the point, Rocky."

"We've tried all sorts of ways to reproduce your runs, Don. Nothing works."

"That's what I hear."

"There's something special in your blood, Don. We need a few cc, just enough for a microanalysis. All you have to do is come in, let the nurse draw a sample."

"No."

"You have a legal obligation, Don."

"So sue me."

From the corner of his eye Nyrock noticed that Kursh was shaking his head.

"We'll pay, Don."

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"How much?"

"Ten thousand." It was really a question.

Dr. Jain's laugh would have been a pleasant thing to hear under other circumstances.

"How much are you thinking about?" Nyrock said hoarsely.

"Well, let's see. You've got a potential market up in the billions. Would a hundred million be reasonable?"

"Donald!" The word was really a squeak. Nyrock turned pale. Sweat began to run down into his eyebrows.

"Your turn," said Jain.

Kursh whispered two words.

"One million," Nyrock said. He added diffidently, "Subject to successful testing."

"No, a million on delivery."

"Our place?"

"Your dispensary. Tomorrow, nine A.M. Check by EFT, my bank, the instant I walk in."

As the meeting broke up, the vice-president asked Dr. Nyrock to return with him to his office on the seventh floor.

"But *Axe*," protested Nyrock, "When I fired him, I just followed orders! *Your* orders . . ."

From behind his desk Axel Kursh nodded sympathetically.

"I know, Rocky, I know. But I think you must agree, your timing was abominable. Another week, Rocky, maybe even another day, and we'd have that blood for nothing. But a *million*, Rocky? Stogie Stokeley is going to demand a body. Sorry, Rocky, it's me or you. Be out by noon tomorrow."

This time the CEO came down from New York. "Even using a million dollars worth of Jain's own blood, it still didn't work? *Why?*" He took the cigar from his mouth for a moment and aimed a blast of smoke across the conference table in the general direction of the No Smoking sign on the opposite wall.

Axel Kursh coughed delicately. "We don't know, Mr. Stokely."

"Call me Stogie," Stogie said. "Perhaps something in the way the blood was drawn?"

"Ms. Bailey?" Kursh said.

The nurse sniffed, put a handkerchief to her mouth. "Standard procedure. Dr. Jain came in at nine o'clock. I personally drew the blood. Exactly the same procedure as a thousand times in the past. Thump the arm, find a good vein, swab it, stick the needle in, draw it up. In this case, six cc, discharge it into the ten cc anti-coagulant blood tube, stopper the tube, send it down to analytical. Whole blood. We took nothing away."

"Perhaps we *added* something?" Dr. Rothkull said.

"Sir?" Ms. Bailey's query hung between indignation and surprise.

"EDTA," said the hematologist. "Ethylene diamine tetraacetic acid, sodium salt. Standard practice to add a 15% solution as a preservative?"

"Well, of course. In fact, it's already in the vials, before the blood is even drawn. Sir."

Rothkull sighed. "Let's think about that. Normally a blood clot forms from the polymerization of protein fibers circulating in the blood. A variety of proteins is involved in the mechanism, and blood won't clot if they don't work together properly. That's why EDTA is a fine anticoagulant for blood. It pulls one or more of the clotting proteins out of the loop. The mechanism is a bit fuzzy, but we think it chelates some of the metal-carrying oxidoreductor enzymes, probably including one or more of the low molecular-weight redox metallo-enzymes essential to the Jain process." He shrugged. "Most regrettable. We need another sample, this time no EDTA, rush it right in to analytical."

All eyes turned to Axel Kursh. His voice was lifeless. "He will want more money."

There was a short silence.

Then Stokeley began waving his cigar

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like a cudgel. "What am I hearing? We already *gave* the rogue a million. You mean he will want *more*? I don't believe this! Whatever happened to company loyalty?" He clenched his teeth furiously and looked around the table. "We'll see. And will somebody find me an ashtray. Axe, get him on the line. I'll talk to him."

The call went through promptly.

"A *million*, Donald? But we *gave* you a million. *Another* million? Have you no sense of ethics? Do you realize what you've done to this company? On account of you we've had to *retain* people in analytic . . . microbiology . . . marketing assessment . . . sales . . . stockholder relations . . . PR . . . even legal. We've had to rehire people, expand several departments, all just to deal with your crazy process. You've completely *wrecked* our downsizing program. And now you want *more*? Oh, *shame*, Donald! Are you totally devoid of honor? We're the laughing stock of *The Wall Street Journal*, *Forbes*, *Fortune*, the whole financial world. You name it." He paused, panting.

They listened to Jain's calm voice on the speaker. "You misunderstand, Stogie. What I have in mind now for the company is a million dollar, *package* deal, something that could prove very useful, not only to the company but to you personally. The second million gets you blood plus full rights to my *new* invention."

"No, Donald. Look, all we want is a little blood. We don't need your new invention. I'm sure it's really terrific, but we just don't want it. It's just the blood. Okay? Let's be reasonable. A hundred thousand, just for the blood. That's the most I can approve without going to the Board." He hurried on. "You have to appreciate my situation here, Donald." He lowered his voice. "I'm walking a tightrope. Any more funny business, any more negative PR, the Board votes me out. The next CEO might turn you down altogether. It's you and me, Donald."

They listened to the voice on the speaker. "I understand the difficulty, Stogie. I wouldn't think of embarrassing you. Good-bye."

"Wait!" But there was only a dial tone. Stokely stubbed his cigar in the waiting ashtray. Someone carried it out of the room. "Get him back, Axe," the CEO said grimly.

The eyes of the vice-president and chief executive officer locked briefly, and Kursh read doom in the exchange. He thought of his two sons in college, a heavy mortgage, expensive car, expensive wife, and wondered if this second million would come out of his severance package.

The connection was fast. "We can deal, Donald," Stokeley said bitterly. "A million. Same as before?"

"Sure, Stogie."

"Oh, incidentally, what's your new invention?"

"Glad you asked. It's an extract from a fungus growing over my septic tank. It's all in the descriptions. You get the entire package, Stogie—patents, know-how, everything, all part of the package, along with the blood. The consortium will sit up and take notice! I'll call a press conference, invite the local papers, *Time Magazine*, *USA Today*, *60 Minutes*. You're invited, of course. Check to my bank by EFT?"

"It's on the way, Donald. Not that it matters, but what exactly does this extract do?"

"It's a sure cure for nicotine addiction. Hope to see you there, Stogie!" ■

Loquacity has many pitfalls, but silence, none.

— Apollonius of Tyana

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USING DNA TO SEARCH FOR DARK MATTER

Physics research has a long and successful track record of using new tools taken from evolving technologies to investigate important physics issues. In this column, I want to describe a new and novel proposal for detecting dark matter using a new technology which, up to now, has never been employed in cutting-edge physics experiments: the new technology of molecular biology that has recently been developed for the Human Genome Project. In particular, I will discuss a proposal for detecting WIMPs using DNA molecules. Let us start with a discussion of WIMPs and the Dark Matter Problem.

Over the past two decades we have come to realize that the ordinary matter of our universe, the stuff that forms quasars, galaxies, stars, planets, people, atoms, quarks, etc., is only an insignificant fluff, a minor impurity that permeates the real material of the universe, the unknown invisible substance called "dark matter" (See my previous Alternate View column "The Dark Side of the Force of Gravity", *Analog*, February 1985). Dark matter accounts for more than 90% of the total mass of the universe, yet we have no idea what it is.

Astronomers discovered dark matter while using the Doppler-shift technique to measure the velocities of bright stars orbiting distant galaxies and galactic clusters. Roughly speaking, any orbiting object must have a velocity that depends on the square root of the amount of mass within the spherical volume enclosed by its orbit. As the distance R of the bright star from the center of the galaxy or cluster increases, it is expected that the star's orbital velocity should first increase in proportion to R, as long as it is at a radius within which the stars of the galaxy are distributed fairly uniformly. When the bright star is at a large radius outside the galaxy, so that the sphere of radius R encloses essentially all of the mass of the galaxy or cluster, the velocity of the star should fall off as the inverse square root of R. Thus, the average mass and mass distribution of a galaxy can be estimated by measuring the velocities of a number of bright stars at various distances from the galactic center.

To the surprise of astronomers, the velocities measured in this way were much larger than expected from a galactic star count, and it was found that the orbital velocity continued to increase with R far beyond the visible radius of the galaxy. This is convincing evidence that the visible mass of a galaxy, even after correcting for non-luminous "brown-dwarf" stars and interstellar gas, is much too small and too localized to account for the observed orbits. The conclusion from this work is that most of the mass of galaxies comes from some mysterious dark matter. Furthermore, this invisible

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dark-matter mass is distributed much more broadly than the visible stars in the galaxies studied. This mystery of the origin of this extra mass has come to be known as "The Dark Matter Problem". It is one of the outstanding unsolved problems of contemporary astrophysics.

The Dark Matter Problem has prompted a close examination of all theoretical possibilities for the missing mass of the universe. Theoretical particle physicists over the years have predicted scores of could-be particles that have never been observed in the laboratory, and many of these have become "dark-matter candidates": particles which, if they existed, might account for the hidden mass of the universe. Among these dark matter candidates are axions (see my February 1985 Alternate View column in *Analog*), massive neutrinos (see my September 1992 column), and more generally, a whole class of weakly interacting massive particles otherwise known as "WIMPs" (see my May 1986 column). Many experimental physics groups have initiated searches targeted on one or more of these candidate particles, but none have been successful. There have been some inconclusive hints of neutrino mass effects, of larger-than-expected brown-dwarf contributions to galactic mass, and perhaps of a non-zero cosmological constant that might give space itself a significant mass density. However, at this writing (February 1998), no "smoking gun" has been found to reveal the secret identity of dark matter particles.

In a typical neutrino or WIMP search, a large, dense volume of sensitive detector material is placed underground in a low-radiation environment. Examples of such experiments are the solar neutrino detectors (e.g., Homestake, Kamiokande, SAGE, SNO, etc.) placed deep underground in a mine, with the mine location selected so that background from radioactive decays in the surrounding rock is low, and so that the detector is deep enough underground to be wel shielded from cosmic rays, particularly the highly penetrating mu mesons. The detector material is chosen so that interaction with the particles of interest, e.g., dark matter WIMPs, produce detectable change in detector material or directly generate a detectable signal.

For example, an energetic neutrino may be detected by transmuting detector material into a radioactive isotope (as in the Homestake ^{37}Cl based neutrino detector) or by producing a flash of light arising from scattering, interactions, ionization, and Cerenkov radiation (as in the SNO and Kamiokande detectors). In either case, for each detected particle a large amount of energy must be deposited to produce the transmutation or ionization that constitutes the signal. Transmutation requires deposition of 2 to 10 million electron volts of energy, while production of Cerenkov light flashes from ionization in water requires an energy deposition of 1 million electron volts or more. However, adding scintillation chemicals to the water can reduce the minimum energy to around 100 electron volts. If less energy than this is deposited, the detector will not produce a signal. (Note: to set the scale, 2 electron volts is roughly the energy content of one photon of visible yellow-orange light, and 511,000 electron volts is the mass-energy of one electron.)

Dark matter has not so far been detected by existing experiments, and perhaps this is not surprising. Theoretical calculations suggest that interactions of matter with WIMPs may liberate only a few electron volts of energy. Therefore, to "push the envelope" of dark matter searches, physicists must design a new generation of detectors that can function with a smaller deposition of energy per detection event. This might be accomplished, for example, with a small gas-filled detector or with a phonon-sensing solid state device. However, such detectors are too small and/or too low in density for efficient detection, and one might have to wait many

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centuries to detect enough events for a believable signal. It is much more difficult to design the sensitive large-volume high-density detectors needed for efficient WIMP detection.

Dr. Richard J. Muirhead and his collaborators at the University of Washington have proposed an innovative solution to this problem. It exploits the properties of the molecules of life, DNA. The amount of energy required to break a single chain of DNA is on the order of 10 electron volts, at least a factor of 10 lower than the energy threshold of previous detectors. The Muirhead scheme suggests placing a large volume of DNA solution in a well-shielded location and monitoring the rate at which DNA chains are broken.

Single DNA chains with a repeating single purine base, for example an adenine chain of the form A-A-A- . . . , are commercially available in bulk quantities and in a variety of lengths. Using standard molecular biology techniques, a molecule of biotin ($C_{10}H_{16}N_2O_3S$, a colorless crystalline member of the vitamin B complex) is attached to one end of a 20-base DNA chain, and a fluorescent probe molecule (FITC) is attached to the other end.

A large quantity of these molecules are placed in a water solution and exposed to WIMPs or to calibrated amounts of radiation. After a suitable exposure, the solution is passed through a streptavidin column. Streptavidin has a remarkable affinity for biotin and binds to it with a very high probability, so that the biotin ends of all the DNA chains should be captured in the streptavidin column, but any fluorescent FITC end of a broken DNA chain will flow through the streptavidin column without interaction. The solution from the column is then exposed to ultraviolet light and its fluorescence accurately measured, thereby providing a quantitative indication of the number of DNA chains broken during the exposure.

A more sensitive variation of the same technique, currently under consideration, might attach a strand of RNA rather than FTIC to the DNA ends, and then use an RNA amplification technique similar to the polymerase chain reaction (PCR) to repeatedly duplicate any RNA from broken chains. This might permit the detection of one single broken DNA chain which occurred during the exposure, out of all of the DNA in a large volume of solution.

This scheme for searching for WIMPs is still in the development and proposal stage, has not yet received major funding, and has not been tried on a large scale, but it offers the promise of bringing greatly increased sensitivity to investigations of the Dark Matter problem. However, even before this type of WIMP search has been attempted, there is some circumstantial evidence that it may be on the right track, evidence again supplied by the biological sciences.

The Earth orbits the Sun with an orbital speed of about 29,800 meters per second, about 0.01% of the velocity of light. If the WIMPs orbiting the center of the galaxy are in our vicinity, we should encounter more of them when the Earth's orbital speed is directed against the WIMP stream then when it is directed with the stream. Therefore, if WIMPs break DNA chains, one might expect a yearly variation in the mutation rates of living organisms. Two groups have looked for annual variations in the mutations rate of fruit flies, an insect widely used in laboratory-based mutation experiments. Both groups found that there is about a 15% variation in the mutation rate over the course of a year. These results are not conclusive, since such annual variations might have other causes (variations in environmental light intensity, humidity, temperature, etc.), but they suggest that there could be some validity to the notion that WIMPs can break DNA chains.

Will the Dark Matter problem be

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solved using DNA and the techniques developed for the Human Genome Project? That is difficult to say. The method described above has the needed sensitivity to small energy deposition, but there are very formidable problems with background that must be addressed and overcome before it can be used for quantitative measurements. And the method has the disadvantage that one must essentially destroy the detector in order to read out a signal, removing all of the detector's DNA to the streptavidin column in order to make a measurement. Some flow-through scheme would be preferable, in which broken chains were continuously removed from the solution, but the unbroken DNA chains were returned to the solution and remained as active detector elements. But in any case, this technique represents a new synthesis which brings ideas from both physics and molecular biology to a sharp focus on an important fundamental problem, the basic structure of the universe. This is perhaps the first example of a brand new trend in basic physics research.

AV Columns On-line: Electronic reprints of 87 or so past "The Alternate View" columns by John G. Cramer from *Analog* are available on-line on the Web at the URL: http://www.npl.washington.edu/av ■

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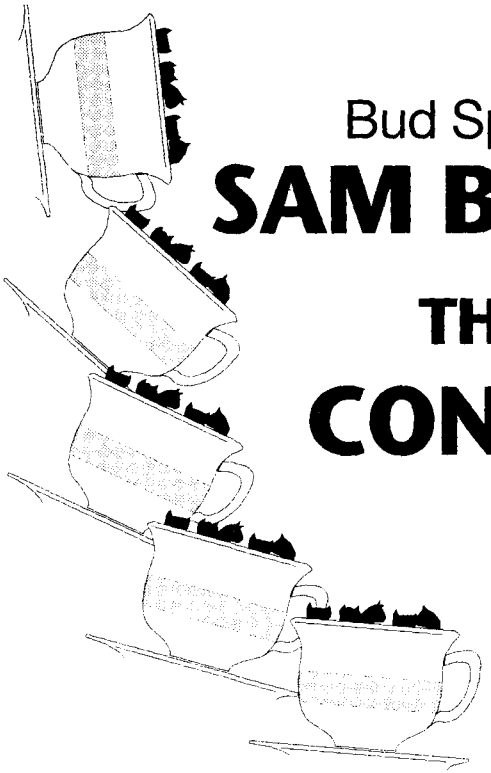

Bud Sparhawk

SAM BOONE AND THE TEACUP CONUNDRUM

And you thought chaperoning a grade-school field trip was challenging?

Illustration by Shirley Chan

The wording on the sign was unequivocal; "You cannot go on this ride if you are shorter than this line!" The bright red horizontal line was a bare meter-thirty above Sam Boone's feet—and at least six centimeters higher than the head of one of the Kittchikoostrans—catlike, black-clad galactic tourists—who was standing beside him.

Hisssss! "What does this say?" the nearest Kittchikoostran insisted and angrily hissed something to the others in its own unearthly language. The untranslatable speech was quickly echoed by the fifty-three nearly identical copies of the speaker. All were attired in similar black, skin-tight uniforms.

"Well?" the testy Kittchikoostran hissed as it impatiently scratched the walkway. Sam gulped when he noted the depth of the gouges the Kitties's claws were making in the tough paving. He'd learned earlier that the Kittchikoostrans were as deficient on patience as they were on altitude.

"It says there's a four-hour wait," Sam lied smoothly and glanced around for some diversion. "Say, let's try that one." He pointed to the Hall of the Ex-Presidents across the way and quickly began walking in that direction, hoping to lead them away from a potentially disastrous refusal by the operators of the ride. The fifty-some aliens hesitated for a moment and then marched in lock step behind him. Sam wiped the sweat from his brow and let out the breath he'd been holding.

God, why had he ever allowed himself to be talked into escorting these perpetually hissed-off aliens to Disneyworld—where they thought they were, having not yet detected Sam's slight bit of misdirection?

After centuries of effort, humanity had finally achieved sufficient technological sophistication and cooperation to build a star-going vessel and had sent it forth to conquer the universe. Within a month of setting out the ship had

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made contact with a member of the galactic hegemony and had returned to inform Earth that the aliens would be arriving shortly.

To become a member of a galaxy-wide civilization, to set foot on planets alien and strange, to boldly go where no man, etc., stirred the minds and hearts of everyone on the face of the Earth! With breathless anticipation the entire planet awaited the arrival of the diplomats, the representatives of the wise elder races, mankind's first visit by extraterrestrial intelligent life forms.

The first galactics to arrive seemed to find humanity's preoccupation with electromagnetism rather quaint and puzzling. "Phloomb," one of these arrivals had proclaimed to Earth's leaders with booming confidence, "is a much simpler and more accessible technology. Would you be interested in buying," the smooth-talking Gelderion had asked in oily terms, "a few hundred phloomb generators, a handful of interstellar ships, a dozen or so long-range ansibles, and a few million fuchsia wutzler-logs?" All were, he assured them, "prime examples of galactic civilization's cornucopia of technologies."

"If you act fast," the alien emissary suggested with a slight edge in its voice, "I can give you some *really* good prices. Just sign here, and here, and put down a slight deposit—say Africa, or maybe South America?"

Needless to say, no nation, with the exception of France, was willing to sell off a goodly hunk of real estate for what might be the galactic equivalent of twenty-four bucks worth of beads. The Gelderion's parting remarks after Earth's political leaders' polite refusal of its offer wilted the closest vegetation and peeled the paint from the walls of facing buildings. Nobody asked for a translation.

Which left Earth to do what any impoverished, backward, technologically unsophisticated culture had to in order to gain sufficient credits to buy things on the galactic market: they let themselves be exploited. At the same time, everyone hoped to discover the niche, *any* niche that humanity could fill so that it could claim a place in the greater hegemonic scheme of things.

And so Sam found himself working for CT&T, Crumptonian Tours and Trade, an alien travel agency specializing in escorting visitors to the Earth's more interesting and exotic sites.

Sam's earlier successes with a variety of alien tour groups had made him the ideal candidate to escort the vicious and temperamental Kittchikoostrans—a race who were not known for their sanguine temperaments. In a rather mild fit of pique, Djef and Dorth, as these two identified themselves, had not only made a shambles of the main (and only) office of CT&T but had left Sam with no eyebrows, several first-degree burns, and a shock of singed hair that became the envy of every teenager who had seen him, such was the sad state of coiffure in twenty-second century Earth.

The Kittchikoostrans were best known for three characteristics. The first, and most important, was that they were group minds. Djef, for example, consisted of thirty-two individual Kitties, while Dorth—Djef's "mate"—numbered twenty-two. Second and third characteristics on the short list, if you will excuse the term, were their hair-trigger tempers and a complete absence of patience. Sam had heard from dependable sources that Djef and Dorth had slagged a transport at one of the way stations en-route to Earth simply because it waited too long to vacate their docking slot!

Sam had been on edge since Mardnn had scheduled the trip to Disneyworld and was constantly alert to any slight or misstep that might set the diminutive aliens off.

On the plane trip down to Orlando, Sam had put the two (or fifty-four, depending on how you wanted to count them) Kitties in coach while he reposed in first class among several resplendently garbed Pequodistas. There, in luxurious

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splendor, isolated from his charges, he had sipped on a cool and highly alcoholic drink to calm his frayed nerves.

The Pequodistas were gray-skinned galactics with large rose-colored bladders on each side of their throats and a tangle of worm-like "fingers" growing from the sides of their heads. Speech, for them, consisted of drumming the bladders with the "fingers" to produce a not unpleasant humming sound.

Hmmmmmmmm. MmmHmmm? "Aren't you the human who sold me those wonderful magazines?" one of the Peqs hummed into a small gray box from which emerged a reasonably understandable stream of glax, the galactic lingua franca. Sam had picked up enough of the language to understand her. He'd seen these translators before. They turned the Peq's humming speech into something other beings could understand.

Sam looked at the speaker. The Peqs all looked so much alike, but now that he thought about it, this one appeared to be somewhat familiar. . . . Yes, now he had it! Just a week before, he had business with a Peq. Maybe this was the same one? Sam stared at the box. That Peq—what was her name?—had one just like it. "Yes," he admitted in response to her question.

Hmmm: "Ahbbbb," the Pequodista introduced herself. "And you are the [untranslatable] Sam Boone who helped me gain much wealth."

"Glad to help, er, *Ahbbbb*" Sam replied, recognizing the name and amazed at the humming translation of his words that emerged from the Peq's end of the translator. "Always willing to help."

"Admired the way you dealt with us," Ahbbbb continued. "I am considering opening an office on Earth, and could use someone with your talents—someone who might want to make a fortune out there." She stuck a thin arm out from the mound of fabric that swaddled her and waved at the heavens. "I need a human to do some travelling for me."

"Thanks, but no," Sam replied. "I have enough money to live quite well. Besides, I still haven't exhausted all of the attractions on Earth, so why should I leave? No, I think I'll stay right here." He raised his glass, took a deep drink, and settled back to admire the tightly rounded bottom of the stewardess as she leaned over to help someone seated up ahead. Life was good.

The Peqs' muted humming conversation had nearly lulled him to sleep when there was a scream from coach. Something told him that it had to do with the Kitties.

As it did.

Sam learned that Djef had savaged a rude passenger who insisted on pushing his elbows into the window seat that had been assigned to one of the Dorth (*how* did *one refer to these weird beings?* Sam wondered?). As soon as they landed and the Kitties had been safely seated on the bus C&T had arranged, Sam agreed to pay for the man's shredded pants and torn tunic, with an additional promise to compensate for the boor's whip burns and sundry flesh wounds, not to mention the poor man's mental anguish for having to cower in the locked toilet for the rest of the trip.

Sam wasn't worried about the possibility of legal action against CT&T: There could be no lawsuit due to the Alien Sufferance and Support Act of '73, which made it nearly impossible for a human to sue a galactic visitor for any act committed through accidents, differing mores, or lack of courtesy. All Earth realized that the potential of lost trade, not to mention the resulting galactic credits, overrode any petty infractions caused by inter-species ignorance.

Of course the people of Kansas City would never be convinced of the wisdom of such policies, given that their famous downtown area had been turned into a smoking crater when one of its restaurants had made some galactic visitors wait three hours for a table—and then had served *meat*! But,

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the politicians assured the city fathers, they would feel differently after the crater filled in with flood water to form a perfectly circular lake. And *that* would be something any reasonable city would be proud to own.

Meanwhile civic organizations everywhere were reconsidering their standard tour itineraries.

The hotel where Sam had made reservations had added its own wonderful complications to the trip.

"You will have to board your, ah, *animals* in the kennels," the clerk remarked primly, with a barely concealed sniff. "We've just received word that this hotel now has a strict 'no-aliens' policy. We got rid of the others this afternoon. Might I add that it was about time, too!" He shot his starched cuffs and flicked a speck of imaginary dust from his sleeve.

Sam tried to contain his anger. He hadn't suspected someone in this business of harboring anti-galactic sentiments. But then, maybe the clerk was from Kansas City. "That's not fair. I reserved an entire floor of rooms for the Kittchikoostrans' express use," he declared. "We paid in advance!"

"I'm afraid that I cannot honor your reservation," the clerk replied, clearly indicating by the tone of his voice that someone had obviously made a mistake in booking the group, a mistake that he intended to rectify on the spot.

"That's a ridiculous, incredibly stupid policy!" Sam yelled in exasperation. "This is Orlando, aliens come here by the hundreds, the thousands! It's the mecca for practically every damn alien who sets foot on Earth." That last was a bit of hyperbole, since Hoboken and Kawasaki's Sushi 'n Ribs were equally famous attractions to the sophisticated galactic travelers. "Damn it, I demand to talk to whoever set this stupid policy. It's the dumbest thing I've ever heard!"

"I'm sorry, sir. Perhaps you could find someplace more, ah, *interested* in your type of clients?" The smirking clerk turned away to burnish a spot on his pristine marble countertop with his thumb.

The Djef speaker had been standing silently beside Sam through the entire exchange. Out of the corner of his eye Sam saw the Kittchikoostran reach for his belt. Sam felt cold sweat break out on his forehead. What sort of fiendish device was the tiny alien about to unleash? He didn't want another damn incident today, no matter how much the clerk and his stupid hotel deserved it!

He started to say something, hoping to divert Djef from whatever he intended, but the alien was too quick. With a smooth flowing motion it pulled an oblong black object from its belt and tossed it at the clerk. Sam's hand darted out to intercept, but the clerk had faster hands, snatched it from the air, and popped it open. "What is . . . ?" he began and then turned red, followed in quick progression by purple, and finally settled on a slightly rosy shade of white as he read the paper that emerged from one end of the container.

"What the hell?" Sam asked as he admired the ability of the clerk to alter his coloration with such speed. It was a trait he'd not suspected any member of the human race of possessing.

"You . . . you . . ." the clerk sputtered, staring alternately at the tiny alien and the paper in his trembling hands, ". . . you things *own* this hotel?" He seemed to have a bit of difficulty squeaking the words out.

Hissss! "Yes, and we are the ones who want these *aliens* out of here, immediately!"

The clerk looked puzzled. "But, but . . . there are no aliens left in the hotel," he insisted. "We threw them all out!"

Three of Djef's tribe leaped onto the counter so that their slit-like green eyes were staring directly into those of the stammering clerk. The Djef speaker pointed its white-topped staff across the counter at the clerk. "You! You and your human kind are the *aliens* we are talking

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about! This is now a restricted hotel. Get all of those who are *not* galactic citizens out—immediately!"

"Move!" screamed Djef when the clerk remained immobile. *Zappft*! A tongue of flame lightly touched the clerk's carefully coifed hairdo. Simultaneously, all thirty-two of Djef's corporate body hissed loudly, a sound not unlike a jet fighter making a low-level pass before releasing its load of napalm. The twenty-two tiny beings that comprised the mute Dorth stood demurely by, lazily cracking their whips in the air.

Sam interceded while the flailing clerk was preoccupied by his blazing hairdo. "Isn't eviction of all the humans a trifle hasty?" he suggested to Djef. "After all, it will take some time to fill the hotel with galactic visitors. No sense turning away paying customers and profits for the sake of principle, is there?"

Djef's speaker stopped its admiration of the clerk's manic dance and whirled around to face Sam. "You speak of principle and profits as if they were different," it said with a puzzled note in its voice. "But I understand what you say. All right," it hissed over the counter, "the humans can stay, but they must pay in galactic credits, none of this quaint Earth currency, you hear me?"

The clerk lifted his smoking head from its refuge beneath the marble counter. "Galactic credits," he repeated blankly, as if trying to grasp the concept of commerce with his limited intellect. "Pay," he said, finally making a feeble connection.

"Shouldn't be too hard to deal with," Sam assured him with only a hint of malice. "The galactic currency's a base fifteen system, with the lower denominations in base twelve. You won't have to worry unless you have to make change."

The clerk's eyes flicked back and forth between Sam and the tiny alien, as if he were still trying to absorb the sudden change in his status. Sam had once seen that same haunted look in the eyes of a trapped raccoon when it heard the barking of an approaching squad of dogs.

Their rooms were very nice. The service was excellent.

The officials at Disneyworld, now a state in its own right, had not been willing to accept Sam's assurances that the Kittchikoostrans were *only* two individuals, not a pack of aliens trying to foil their head counts. The officials persisted in their belief that the number of individual bodies comprising a person was the absolute count rather than, as Sam had insisted, the number of souls in question. Neither did an offer of a small bribe change their minds, which made Sam's attempts fail on both the mundane and spiritual levels. So much for epistemology, he thought, and wondered how he could gracefully manage to get the fifty-four little aliens into the park while remaining within Mardnnn's parsimonious budget.

Since none of the Kittchikoostrans understood Earthlish they left it to Sam to translate the various signs and signals. This was fortunate because it allowed Sam to skillfully divert his alien charges past the gates of Disney World and through those of UniverseLand, an alternative and highly derivative park just outside the legal reach of the great Disney empire.

The forward-looking officials of UniverseLand, gentlemen of refinement and honor, who took Sam's bribe without so much as blinking, did not argue with Sam's suggested head count.

The duck-faced ticket-taker at UniverseLand's park entrance didn't even blink when Sam showed up with his militaristic Kittchikoostrans though the gates. This was not surprising, given the parade of alien visitors who had already passed through these gates over the past few years. Sam doubted that even the *first* alien to enter would have surprised the ticket-takers. After all, when they were daily surrounded by such fantastic

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creatures as a two-meter-tall rat, talking chipmunks, and an array of characters comic, fantastic, and fictional, why would one more bit of weirdness bother them?

Sam had feared that herding the two (or was it fifty-four?) Kittchikoostrans would be like taking a group of second-graders to the park, with individuals and clumps dashing off in all directions. But the Kitties were remarkably well-behaved in that respect, forming in two well-defined groups. Sam thought that someone with a discerning eye could easily detect the small differences between which Kitties were Dorth and those who were Djef. Any sharp-eyed observer would note their slight differences in size, detect a hint of shading in eye colors, discern the way Dorth tilted her head to the right, recognize the perky angle of Djef's ears, and acknowledge that the Djef contingent were all brown while Dorth's were tan (or would that be 'was'?) Sam was always confused when applying human grammar to alien races in general and the Kittchikoostrans in particular.

The walk down UniverseLand's Central Avenue caused no particular stir among the hordes of tourists streaming into the park. In fact, he imagined that most probably thought that his petite aliens were merely another element of the park's magic.

The Kittchikoostrans had no problems on either Ms. Frog's ride or in the whirling teacups—each of which held six Kitties with ease.

"An interesting experience, this continuous alteration of force and direction vectors under variable speed conditions," Djef had remarked as some of its members were whirled around and about. "However, I fail to see why they insist that the riders must be secured. Would it not be more interesting without the bars holding them in?"

Sam tried to imagine the effect of the teacups tossing the diminutive Kitties over the heads of the merry crowd, and maybe splattering a few against the walls of the nearby Capt'n Cook's Samoan Restaurant. "I doubt it," he answered.

Dorth was disappointed when they couldn't get on the Elephant rides. A flock of Netsrots from Lommoruse were hogging every one of the large-eared cars, squealing and screaming as the swooping ride threw their massive bodies outward, held back only by the firm grip their tentacles had on the cars' trunks. The Netsrots were obviously having a hell of a time and signified it by beating the sides of their Elephant cars with their tentacles and screaming at a one-hundred-decibel level, just below the threshold of pain. The Netsrots' long necks were higher than the top of the ride's central mast and, occasionally one of the Netsrots would lean its head too far to the side and whack its beak on the pumpkin cornices of a nearby gingerbread kiosk. The pumpkins, after repeated beak whackings, were decidedly worse for wear and had begun to resemble well-chewed apple cores. On the other hand, the Nesrots appeared to be quite unaffected by the repeated impacts.

Sam noticed quite a few other alien races in the crowd. These were vastly outnumbered by the plethora of humans who were vainly struggling to master UniverseLand's seven thousand acre complex of rides, restaurants, amusements, shopping centers, transportation hubs, and assorted hotels, motels, and hostels.

Many of the human tourists had bright badges that identified them as being on the extended five-day tours of Florida theme parks. These usually guaranteed "Fifty rides per day or your money back!" Sam wondered at the wisdom of setting such a pace as he observed these red-tagged, green-faced tourists being shepherded into the lines for yet another of their daily allotment of rides by their ever-cheerful and perky guides. The guides' sincerity and solicitude might have been more convincing were

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it not for the worn grips of the cattle prods that hung at their waists.

After entering the Hall of the ex-Presidents, Djef and Dorth became fascinated by the smoothly animated robotic characters on the stage, especially the Ronald Reagan one—hardly updated since its days in the oval office. The little aliens grew confused by everyone's laughter whenever the Ford automatron tripped, and became even more so when the Clinton robot patted thwell-upholstered behind of Madame sixty-ninth ex-president.

The more recent presidential robots were even more boring than their real-world counterparts, if possible. Such, Sam reflected, had been the unexpected consequence of the probity the electorate demanded in its candidates. Lack of any sort of enjoyment or business involvement whatsoever had become the watchword for candidates. Cal Coolidge's looked like a party animal in comparison with robots of the last forty presidents.

After they left the ex-President's Hall things began to go more smoothly than Sam had expected, given the nasty disposition of his charges. But that could have been expected; the sight of the regiment of Kittchikoostrans perambulating in syncopated synchronicity kept most people, and *all* of the other aliens, away from any troubling confrontation.

Things were going so well that Sam relaxed for the first time in days and actually began to enjoy himself.

Then they came to the Tiny Universe ride.

Sam had his group of Kitties lined up in a row and waited until enough boats arrived to mount everyone (both of them?) at the same time, earning him not a few grumbles from the waiting crowd of adults accompanied by their impatient children, many of whom became quite vocal over the delay.

"Why do they have to bring kids to a place like this?" Sam grumbled as he climbed into the lead boat. He could faintly hear the ride's music from the opening just ahead—"It's a teensy-tiny, eeny-weeny cosmos. . . ." The tune was somewhat catchy, despite its familiarity.

Once they were all loaded into the boats, they began to move smoothly forward through the entrance and slowly past the tiny dioramas. From every direction came the endless, repeating "It's a teensy-tiny, eeny-weeny cosmos. . . ." The music continued unabated as the boats wove their way among the displays. The Kittchikoostrans quietly observed the hundreds of tiny dolls, each group resembling some alien life form. Every member of the galactic hegemony was there, all arranged in suspiciously, if somewhat contrived, cute, exotic settings.

Sam had met just a few of the represented races. He recognized the huge lumbering Dermitts from the disastrous Kansas City trip, although the dolls didn't sport the huge blasters of the originals. He recognized the group of resplendently clad Pequodistas and, beside them, the slithering, purple Glerens. Sam laughed with recognition of the furry blue Freisnilles who'd once helped him ruin the craps tables at Atlantic City. But the remainder were some he had never encountered or seen—it appeared that the galaxy had produced a host of forms even more varied and strange than anyone *could* imagine. Sam's boss, for example, was a grumpy, sessile, blue cone of a creature with a single eye stalk and tentacle, which was quite an improvement over the agent with whom he'd formerly worked.

Still, the exhibition within this particular ride was wider than he'd expected. Apparently the management had spared no expense in getting all of the races that had visited the Earth into the display in one form or another. How they knew the proper backgrounds for the various alien worlds was beyond Sam's ken. It was enough that his charges seemed to be enjoying the parade of

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condensed galactic culture although, Sam noted, there *was* a slight twitching of their ears whenever the music loop started to repeat "It's a teensy-tiny, eeny-weeny cosmos. . . ." The twitching seemed to grow more pronounced as the long ride progressed.

They were just passing the Imperials' exhibit, where some dolls who resembled that race were flashing their communication organs (or were they sex organs? Sam could never get it straight) in syncopation to the saccharine music, when the boats jolted to an abrupt stop.

"Just a minor problem," Sam reassured Djef and Dorth as they rose in obvious panic. "We'll start moving soon."

Whatever had halted the boats apparently did not affect the music, for it continued to repeat, over and over, the same lyrics, the same notes, the same sickeningly sweet, gooey, sugary tune, and those maddening, appealing words, "It's a tiny, eeny-weeny cosmos. . . ." The loop continued over and over until Samthought he would go mad. Already, his mind was anticipating the loop as if the notes and lyrics of the song had been burned into the neural pathways of his brain. The song drove out all other thoughts, all other functions. He felt himself entering a trance-like teensy-tiny state of eeny-weeny being.

A flicker of movement to his right caught his attention. He turned his head. One of Djef was standing on the seat. Its ears were folded back tightly against its skull as if to shut out the dreaded sound of "It's a teensy-tiny, eeny-weeny cosmos. . . ."

Hisssssss!! the assembled Kittchikoostran shouted as one, or two actually, as the speaker's blaster belched forth hissing flames of intense white flame that incinerated the tiny figures, flaring their little doll clothing to bright sparks of incandescence, and melting their teensy-tiny faux alien heads into eeny-weeny puddles of molten plastic.

The music continued. "It's a teensy-tiny, eeny-weeny cosmos. . . ." over and over and over and . . .

With a scream like the very banshees from hell, Dorth, all twenty-two of her, leaped from the boats and ran amok, slashing at the displays with her whips, beheading the dolls, destroying the settings as they clambered up, up, and up to reach the speakers mounted on the overhead girders. Bright sparks leaped as they ripped the loudspeakers from their mounts and tossed them into the water below.

But the music didn't stop. From the settings ahead and behind came the faint repeated strains of "It's a teensy-tiny, eeny-weeny cosmos. . . ."

Hisssss! The Kitties screeched as the Djefs deployed to attack the forward regions while the Dorths concentrated on the nether. There were screams of adults and children as the Kitties wreaked havoc on the interior, battling the hated song to silence, trying to make it stop once and for all.

The boats jerked once. Sam, who had been standing up and pleading with his charges to stop what they were doing, tumbled backwards over the seat and struck his head. For a moment he could think of nothing but "It's a teensy-tiny, eeny-weeny cosmos . . ." repeating endlessly through his mind as a teeny-tiny universe of stars flashed before his eyes. Reflections of the flames from the Kittchikoostran blaster receded behind as his boat moved forward. The song continued to repeat over and over and over and over until he was certain that he was quite, quite mad.

But not nearly so mad as the park officials who greeted him as the boat emerged. Sam found it hard to take seriously someone dressed in the festive fey garb of the park officials—little furry squirrels with fluffy tails appeared to be the costumes du jour—even though, intellectually, he knew better. The squirrels were surrounded, he noted, by a considerable crowd of angry adults. Most of those nearby appeared to have

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wet pant legs and each bore one or two wailing children. All of these were pointing at the boat in which he sat and screaming imprecations.

Sam stepped from the boat with as much dignity as he could muster and discovered that his head was still twitching in time with the pervasive Tiny Universe rhythm. "Is there some sort of problem?" he asked pleasantly as, behind him, the sounds of destruction continued. He tried to still his jerking head when he heard the music loop begin to repeat "It's a teensy-tiny, eeny . . . —SQUAWK!"

Blessed silence ensued.

The crowd flinched back as Djef and Dorth emerged; one contingent sloshing from the entrance and the other from the exit portals. Some of each had tiny hats on their heads, while others waved fistfuls of colored wire that could only have come from the destroyed speaker system.

The squirrelly officials began screaming something at Sam as the Kittchikoostrans lined up beside him. Sam could not grasp what the park wanted from him, for the song continued to loop in his head, drowning out all other thoughts. One of the squirrels, his fluffy tail flapping about his shoulders, made a clumsy grab for the wires from one of the passing Djefs and tripped. As he fell he reached out and accidentally ripped the belt from that Kitties' uniform.

CRACK! Ten whips snapped at the fallen squirrel as another of the Dorth's snatched the belt from where it had fallen. Before Sam knew what was happening he found himself being propelled along by a half dozen of (or was it one-ninth of?) the Kittchikoostrans. Djef formed a brown flying squad ahead as Sam and his escort raced through the crowd. Dorth's tans followed and provided a rear guard for their escape.

"No, no," Sam screamed. "Stop! Put me down! I can handle this."

But neither of the two Kittchikoostrans listened. They raced across the footpath, down a slope, past a sign that said, "Your wait will be three hours from this point," and around two barricades, where they astonished a crowd of waiting passengers, who clapped their pleasure at this unexpected bit of excitement.

One of the Cajun Country's longboats had just emptied as the racing Kitties, still carrying Sam, rushed the pier. Three of Djef's cohort tipped the surprised steersman into the drink while the rest piled themselves and Sam on board before shoving the boat away from the dock.

"Hey!" yelled a piratically-clad attendant as he tried to simultaneously keep the waiting passengers from falling into the empty space where the boat had been while attempting to grab the longboat's rail. With his attention focused on two dimensions he forgot the third and tumbled into the ersatz river, alongside the drenched steersman.

And then the boat was around the first turn and out of sight of the angry and confused pirates, although not out of earshot of their other shouting pursuers. The half-dozen of Dorth who were holding Sam finally released him. He immediately sat up and tried to figure out where they were. As best he could recall there wasn't a canal system leading out of the park, so this must just be another ride—not an escape route.

BOOOM! There was a flash of cannon on the left as they rounded a bend and came upon a representation of a pirate's enclave. BOOM! The cannon sounded again and there was a splash next to the boat. All of the Kitties on that side were drenched by the spray. As one all of the Kitties looked toward the smoking cannon. Their ears were pinned back against their skulls and their teeth were bared.

"NO!" screamed Sam as he suddenly realized what was about to happen. But his shout was too late. Djef's reaction had been immediate and decisive. As one, all thirty-two of Djef's bodies

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whipped out their blasters and lay down a fusillade of fire that set the entire pirate fort ablaze, not to mention melting much of the surrounding plastic forest. But the uneven firefight was cut short as the longboat made another turn around a bend, which hid the devastation they had caused from sight, but revealed a crocodile with jaws agape snapping at their side.

Zappft! Four simultaneous blasts from the hand weapons were enough to render the ersatz croc into an expanding cloud of component plastic and metal parts. Sam flinched as the rain of automatronic organs showered the vessel. Through the descending cloud he caught a glimpse of several bespotted agents of the Squirrel charging through the jungle. They seemed to be running parallel to the river's course.

"Pull into the bank up there," Sam suggested, pointing just ahead. "Let's wait for them there." Perhaps he could still manage to talk his way out of this increasingly dangerous situation. Yes, this was definitely a time for conciliation.

The many heads of Djef jerked around at a shout from their dogged pursuers. Dorth grounded the vessel on the bank opposite the spot Sam had indicated. Sam was quickly Kittie-handled over the rail by Djef, pushed, pulled, prodded, and yanked along with the mass of black-clad Kittchikoostrans as they raced up a bank, leaped a low fence and charged onto a walkway, scattering civilians in all directions.

"Which way?" Djef hissed quickly. "How do we make our escape?"

"You don't have to escape," Sam tried to explain. "Let me take care of this. It's all a misunderstanding."

Djef's angry response told Sam that it was obvious that the Kitties were in no mood to palaver now that they had their dander up. Any attempted discussions with their furry pursuers were doomed to failure, or worse!

Sam looked around, trying to identify something familiar, some landmark that he could use as guidance for their escape. There! He caught sight of the park's flag-covered ramparts, which could be seen from every spot in the park. Perhaps, if he could get the little aliens to a place where they could be trapped while appearing to be secure, he could prevent this disastrous turn of events from getting any worse.

"This way!" he yelled and the fifty-odd charged.

"Uh-oh!" Reinforcements were bearing down upon them from the direction of a distant medieval castle, cutting off that line of travel. "That way," Sam yelled, pointing south, toward the Old West exhibits. Djef and Dorth turned as one. The Kitties in at the van threw blazing bolts over the heads of their pursuers.

Sam thought furiously as he pounded along with the Kitties, trying to think of some other way to avert disaster. Where could he secure the maddened aliens for whatever time it would take to calm them down? What was there. . . .

He had it!

Now, the only problem was getting them there. He quickly reviewed his options: Should he lead them through the Old West or take a detour through Bobcat Country? He decided on the latter since the automatronic gunslingers of the Old West would probably set off the Kitties even more.

They bypassed the lines of docile tourists standing under the signs that declared "From this point you have a two-hour wait," ran through the entrance and into the middle of a performance by the singing musical bobcats. One of these was raising his trumpet just as the first few of Djef leaped through the door.

Zappft! One blaster bolt caught the bobcat in midlift, rendering his trumpet, arms, and much of his head into a ball of flame and spitting sparks. Children in the audience squealed with delight as the catlike aliens leaped onto the stage, dodged among the automatronic bob-

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cats, and headed for the red exit sign. Sam panted with the effort as he tried to keep up.

They exited and ran into a crowd encircling a huge chicken who was sputtering wildly in apparent exasperation, much to everyone's delight. As soon as the fifty-some Kitties ran into the area, everyone, adults and children alike, turned to watch this new diversion. Djef and Dorth organized themselves into flanking squads that could cover every approach while they waited for Sam's next bit of guidance.

Wham! A flying wedge of state troopers and local constabulary burst through the flowering shrubbery at the head of a mixed squad of brightly clad characters that had chosen to accompany their pursuers. Along with the sweat-drenched and lightly scorched squirrels, there were some technical types in orange coveralls and various sundry historic comic book characters.

From the reaction of the Kittchikoostrans Sam knew that there was going to be an armed confrontation unless he did something, and quickly! People were likely to be harmed, chief among which was his own precious self. He had to do something.

He searched about for something with which to distract either side—something that would draw attention, relieve tension—and then he spotted it.

With a scream he ripped the chicken's head off and rolled it at the advancing cartoonish crowd as if they were a set of tenpins. The lead man tripped over the rolling head and went down, followed by a handful of his followers.

Meanwhile the children were screaming that Sam had murdered their damned chicken, which was now turning in ever-increasing circles and squawking at random as it trailed sparks from the brightly-colored wires in its neck. For some reason Sam had expected to find a human being inside the suit, not a robot.

But there was no time to reflect on the vagaries of the latest version of the Equal Opportunity Act while the pursuit was distracted. "Follow me!" he yelled and pushed through the thin fringe of brush that separated them from the park's railway.

Luckily, a chubby-faced train was coming, moving at a sedate walking pace and emitting wheezes and puffs more suitable to an eighty-year-old marathon runner. Sam leaped onto the smiling purple engine as Djef and Dorth forced their way onto the cars behind.

"Hey!" the bushy-mustachioed engineer said as Sam reached for the throttle.

"No time to talk," Sam said and shoved the lever all the way forward while he held the engineer at bay with his foot. The train started to accelerate, first achieving a trotting speed, then a brisk run, and finally started to really move out, leaving the pursuers behind.

The engineer took one look at the hissing Djef, still wearing his Tiny Universe hats, who had appeared from behind, screamed and leaped from the train.

"Where are we going?" the Djef speaker asked.

"To get you out of here!" Sam shouted back and waved gaily at the waiting crowd on the platform as the train raced through the station without stopping. Lord, he hoped that he remembered the layout of the park right. Unless he was mistaken the next stop would be . . . Yes, there it was—Galaxyland!

He pulled the throttle back and applied the brake, bringing the happy-faced train to a sudden, silent halt. "This way!" he said and leaped off with the Kittchikoostrans following like lambs to the slaughter.

Sam raced around the side of the Galaxyland station, across Astro Plaza and into an entrance decorated with flashing lights and sparkling screens. Desperately he pushed the waiting crowd aside, leaped barriers disguised as handrails, and charged across the display areas without regard for signs or

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distractions. Only occasionally did he glance back to make certain that his alien crew was following his lead.

There! This was the ride he was looking for. Fortunately a ship had just disembarked. He took out the leading group of tourists who were heading for the ship with a body block and waved the Kitties into the ship. "Go, go! I'll hold them off!" he yelled.

With uncanny precision the fifty-odd Kittchikoostrans filed into the waiting spaceship. "Come on!" Djef yelled from within the hatch. Sam raced forward, grabbed the edges of the hatch, and slammed it shut in Djef's face, dogging the hatch firmly in place.

With a roar of flame and a rocking motion the ship lifted off and rose out of sight through the hole in the overhead.

Sam waved bye-bye from the launching pad at the Kittie faces pressed tightly to the portholes, breathed a sigh of relief, dusted himself off, and turned to the advancing attendant.

"If you value your life you'll keep them in that ride until I get back," he instructed. Above his head, the ship was twisting and turning to simulate an interplanetary trip, going around and around and around, following the endless rail that supported it.

It took the rest of the day for Sam to convince Mardnnn, the head of CT&T, that he should use his insurance policy to pay UniverseLand for the damages inflicted by the Kitties. The UniverseLand officials released Sam once CT&T's insurance agent confirmed that they would be adequately compensated.

"Vladish dam you don't come back!" Mardnnn had spit out angrily when he learned of Sam's deceit. "You fried!"

"You mean *fired*," Sam corrected his boss' poor Earthlish.

"That, too!" Mardnnn replied. "And if you come back you *fried*!" Sam had no doubt of his meaning.

Sam's Kittchikoostrans had been pulled from their looping trip hours before, much mollified by the endless circling and tumbling action of the spaceship ride. They had been sent back to the hotel under armed escort consisting of a crack team from the Florida National Guard and a flying squad of state police, none of whom, for some strange reason, seemed too keen on the assignment.

Sam took a bus back to the hotel with a group of richly clothed Pequodistas. They turned out to be the same ones who'd been on the plane. Ahbbbb had a black-eared hat perched on her head, nestled amongst her writhing medusa-like appendages.

From the pleasant humming among the crowd of Peqs it appeared that they had thoroughly enjoyed their trip to Disney's Epcot county. Ahbbbb mentioned that they were looking forward to visiting UniverseLand the next day.

"Stay away from the Tiny Universe ride," Sam warned them as the bus pulled up to the hotel. "It's a killer!"

Sam waved goodbye to the cluster of Peqs and stepped out. No sooner had his foot touched the pavement than, from far above, he heard a loud hiss. He looked up.

All the windows along the seventh floor were open and from each projected at least one Kittchikoostran head. Sam waved at them, glad to see that they weren't holding a grudge for his deceit. "It's Sam!" he yelled. "I'm back—everything's all right!"

Zappft! Twin bolts of blaster fire hit on either side of him. A third bolt singed the emerging hairs of his head, while a fourth ignited the corner of his jacket.

Sam jumped backwards into the bus as the driver pushed the pedal to the floor to get out of the alien's field of fire. He rolled on the floor while the Pequodistas smothered his jacket's flames.

"About that job offer," Sam asked as Ahbbbb helped him to his feet. "Is it still open?"

Hmmm, Ahbbbb hummed. Her translator did not respond. She lifted it up and thumped it hard with her fist, then

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shook it until little rattling sounds like broken glass come from within.

Why not take the job? Sam thought as he waited for her answer: This might be a chance to visit other worlds, an opportunity to travel where no man had gone before, to open hew horizons, to explore, to learn, to discover what's over the next ridge, to become filthy rich, and to simply get away from these sore-assed Kitties and his homicidal boss. Taken altogether, these were appeals that no red-blooded human male would refuse.

HMMMMM! Ahbbbb said emphatically. "Yes, the offer is still open," the box finally translated.

"When can I start?" Sam Boone said with a smile, sticking out his hand to close the deal. ■

(EDITOR'S NOTE: This story precedes other stories of Sam Boone, including: "Sam Boone and the Thermal Couples", "Sam Boone's Dry Run", "Sam Boone's Appeal to Common Scents", and is the sequel to "Sam Boone's Rational Choices".)

IN TIMES TO COME

Our lead novella for October is "Ashes to Ashes," a new entry in Grey Rollins' continuing saga of how the Holmes Door opened the Moon to human colonization. The trouble is, of course, that children, as they mature, tend to grow apart from their parents—even if "parent" and "child" are worlds. Growing apart can lead to conflict, and that conflict is not just abstract and political, but personal—even if not everyone involved is a person, as we usually understand that term. . . .

Our new format gives us room for quite a mix of additional fiction, including stories by F. Alexander Brejcha, Jerry Oltion, Brian Plante, and Rick Cook, plus a fact article by Stephen L. Gillett, Ph.D. on "Near-Term Nanotechnology." Dr. Gillett, interestingly, started out as a skeptic about this newest industrial revolution, but has gradually become convinced that its potentials are not only real, but already beginning to be realized.

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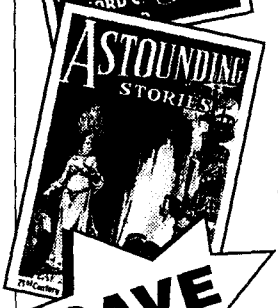

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Kathy Oltion

WHILE YOU WAIT

Some aspects of business stay the same through changes in technology. Others get really different!

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"*Nobody Cares About Your Teenage Angst*," the parrot said. "Yeah, I think that's probably one of the best songs I ever wrote."

For a guy named Jet, he had to flap his wings a lot to keep airborne. He mostly just sat on one of the three wooden beams in his twelve-foot by twelve-foot room, preened his bright green and blue feathers and complained. That is, except when he had a captive audience.

"Me and the boys, we'd knock the kids out with that one. Rogie'd start poundin' on the skins and Hash'd be screamin' on the axe. Betcha don' see nuthin' like that these days." Jet Black paced up and down on the beam that hung at eye level from the ceiling of his private room at the Marilyn Quayle Aviary and Cryogenic Laboratories.

Bill, Jet's current captive audience and latest caretaker, noticed that Jet waved and flapped his wings when he talked. He figured the musician probably used to gesture with his hands when he was in his own body. Bill turned away to dish out bird seed and listened politely as the parrot continued. "Gawd, those lyrics were scarin'. I mean—*hey*! What'd ya think yer doin'?"

"What?" Bill asked. The sharp tone in Jet's voice caught him by surprise. Ms. Chan, his supervisor, had warned Bill that Jet had a bad temper and he *had* been kind of surly when Ms. Chan introduced them, but Bill thought Jet's bad mood had been due to the presence of Ms. Chan. Her stern businesslike manners certainly kept Bill on edge.

Jet was only Bill's second bird-person, or "client" as the Aviary people insisted on calling them. The first had been a woman whose clone was just about ready to receive her soul, her "essence" she liked to say, back into it. She had been easy to deal with, being happy to get back to human form and all. Jet was another story altogether.

"Jeezus, look at that. You're spillin' my special Colombian-grown millet and nuts all over the freakin' floor, you moron." Jet screeched and shook his feathers in irritation.

"I'm sorry, Mr. Black," Bill said, "I'll clean it up."

"*I'm sorry*," Jet mocked. Bill was amazed at how much sarcasm the guy could fit into a parrot's voice. "I'll say you're sorry. You obviously don't know how much that stuff costs. And now it's in the carpet, so you'll have to vacuum and I freakin' HATE the vacuum." Jet's feathers were completely ruffled and his clawed toes were working back and forth on the beam, wearing splinters free.

"I'll take care of the carpet when you go for your afternoon exercises," Bill said, trying to placate the angry bird.

"Fuck!" Jet screamed, "Exercises. I *HATE* the freakin' exercises. I hate this whole freakin' place! And I hate being a freakin' bird!"

"I bet you do, but you won't be a parrot forever. I'm sure your clone'll be ready for you soon." Bill knew that talking about a person's clone made most clients happy. It was like talking about an upcoming vacation. This wasn't the case with Jet though, and Bill immediately regretted bringing it up.

Jet flapped his wings wildly and started squawking and hopping from one foot to the other. Most of what Bill could make out of the noise were swear words. Then Jet flew from one beam to another, squawking louder now and dropping feathers.

Bill started talking to the bird in soft, calm tones. He moved deliberately to the wall with the control panel and slowly dimmed the lights and dropped the window blinds. "Shhhh, pretty bird, pretty bird, pretty bird," he cooed, over and over hoping to reach the main instincts of the parrot itself. It seemed to work because Jet landed on a high shelf, panting a little from the exertion.

"Don't you 'pretty bird' me!" Jet muttered. By now Bill had the lights as dim

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as they could go without turning them off. Jet settled in and started preening.

"Hey, Mr. Black, I'm sorry. I didn't mean anything by it," Bill said. "I apologize. *I'll leave you for a while, okay? Anything* I can do for you before I go?"

Jet didn't say anything. He warily eyed Bill and bit at the edge of the shelf.

"Okay, then, here's your food. I'll be back later, and I'll tell the director that you won't need an exercise session today."

As Bill closed the door to Jet's room, he heard Jet's parrot voice say, "Yeah, right. Tell the old biddy 'e's shagged out after a long squawk."

"Gack! What a day," Bill said to his long-time girlfriend and buddy, Diane. "Thanks for meeting me for dinner, such as it is."

"No prob. I gotta eat too." She paid for her fast food tacos and slipped her wallet into the back pocket of her roomy pants.

They took their trays to a quiet booth way back in the corner of the Taco Shak. They sat down opposite each other on the hard benches and Diane tucked her wavy shoulder-length brown hair behind her ears.

"So what happened?" Diane unwrapped her first taco and dribbled hot sauce into it.

"Hmmmm?"

"You said it'd been a long day. Why?"

"Well, first off, Mrs. Legerski's clone matured enough for soul transfer today. So I lost her as a client."

"Bummer. I know you enjoyed her company." She wiped a bit of hot sauce away from the corner of her mouth. "Does this mean you're not getting paid now?"

"Hmm? Oh, no. Caretakers just get assigned to a new client when they lose the old ones." He chewed his burrito thoughtfully.

"So, are you going to learn how to do soul transfers?" she asked.

"Your guess is as good as mine. I guess if I can stay with the place long enough and take a few courses, I can eventually make it to transfer tech." Bill took another bite out of his burrito.

"I *don't know*, those big birds make me edgy. I think I'd rather be transferred into a cat or something."

"Yeah, you could do that. Almost any animal will do, but you'd have a harder time communicating what you wanted. And the smaller the animal, the more compressed the information that makes you who you are has to be." Bill wiped his fingers on a napkin.

"Compressed? Like a computer program?"

"Something like. All the memories and knowledge and emotions and stuff that makes up the soul or whatever gets scrunched down and downloaded into the host animal. At least, that's how the transfer techs explained it to me at lunch the other day."

"I guess I get it. But what did you mean by 'if I can stay with the place long enough'? What happened today?"

"This caretaking stuff is getting to me I guess."

"Come on, you seemed to like it when you started."

"Yeah. I guess it's just a little easier when you're taking care of a petite little cockatiel whose soulmate is getting a new body any day now." Bill took a long pull off his cola. "Easier than taking care of a large, wicked parrot who has a bitter old rock musician in him."

"Sure it is," Diane said. She'd started in on her second taco when what Bill had said sunk in. "Rock musician?"

"Yeah."

"Anybody I'd know?"

Bill knew how important rock music was to Diane, so he was certain she'd know who Jet Black was, even though Bill didn't. "Probably," he answered.

"Well, who *is* it?" She was leaning over the table so far that her shirt hung open at the neck. Bill enjoyed the unobstructed view of her cleavage.

"Diane, I can't tell you that."

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"Why not?"

"It's called 'Patient Confidentiality.' This is sensitive patient information that I can't reveal to anyone else," he nearly quoted it verbatim from the Aviary regulation book.

"But you told me who your *last* client was: Mrs. Legerski!"

"Yes, and Mrs. Legerski had it announced in all the tabs both when she went into the Aviary and now that she's out. She *wanted* people to know. This one doesn't. Understand?"

"Well, yeah." Diane sat back up and finished her taco. "So, what happened with the rock guy?"

"Oh, not *that* much really. I said the wrong thing and he threw a fit, started flying all around the room and screaming at me. After I calmed him down and left his room, Ms. Chan met me in the hallway. No doubt everyone in the wing heard the commotion. I was afraid I'd lose this job, too. Anyway, she asked what happened and I told her." He slurped the last of his cola.

"And?"

"And she told me I did the right thing, just like they trained me to do. She was real nice about it. Apologized for assigning me to the guy. Said he goes through caretakers 'like parakeets go through newspaper.'" He laughed and added, "I'll probably be yesterday's news tomorrow."

"Kind of abusive, is he?"

"Oh, well. Maybe just temperamental."

"Here, let me refill your drink." Diane took their cups to the fountain.

When she returned, Bill asked, "So how was *your* day?"

"Long, like yours," she said.

"Oh?"

"Yeah, heard back from the latest label. They aren't interested in the demo either."

"Well, then, send it out to the next label on the list."

"They were the *last* label on the list."

"Oh," Bill said. "So now what?"

"Well, I guess it's back to the studio. Except I don't have enough material for a new demo yet." She sighed and fiddled with the edge of her napkin. "So, Billy," she said, not looking up from the napkin, "Do you think your rocker parrot would listen to the demo cube?"

"What?" Bill jerked his head up. He nearly choked on his drink. "Why?"

"Well, if he heard the demo, maybe he could, well, kinda maybe sponsor the band, or . . . or even just give a critique or something." Her words tumbled out of her mouth in excitement.

Bill knew what was going on. Diane was building herself up, but he was afraid this was leading to bad news. "Diane, I can't do that. This person isn't someone you want to deal with. *I* don't want to deal with him as a client!"

"Oh, come on, Bill," she said, "Please?"

He hated it when she begged like that, because it was so easy to give in. He had to be firm on this. "No, Diane. Trust me, you don't want to have anything to do with him. Besides," he said, "I may not be working with him after today." He hoped.

"Oh, okay," she sighed. "It was a stupid idea anyway."

"So, what are you doing tonight?" Bill asked after a moment of silence.

She shrugged. "Don't know, no plans."

"I hear there's a good holo playing at the Max," he said, and then added enticingly, "It's got Neil Fillmore in it."

She looked at him, a smile gradually growing on her face. "Yeah? And how're we going to get there?"

"Hey, I got paid today. We can take the line down and back. My treat." He was smiling now, too.

"So how're you going to pay for that shiny new mag transport if you blow your paycheck on holos and the line?" she asked.

"Just so happens I've been saving between a third and a half of each paycheck since I started this job. Just don't expect holos every night."

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"Neil Fillmore, huh? Okay, you're on." She smiled and together they headed for the line stop.

The next day Bill was surprised to see that he was still assigned to Jet Black. He'd been sure the incident the day before would get him transferred at best, if not fired.

He fed Jet his breakfast, then spent the rest of the morning cleaning the windows in Jet's room. Bill didn't speak much, except for the polite "Good morning" and "Let me know what I can do for you." Jet ate at his breakfast without answering. He spent the morning chewing on his cuttlebone, and watching Bill go about his duties.

Jet was sitting on a parrot swing in front of a full-size poster of his former body when Bill came back from his lunch break. It was one of many posters tacked up around the room. Most of them had been around from the rocker's first heyday, or so Bill figured. This one was made of a plasticized paper and had been rolled and unrolled many times. One corner was torn off and another close to it.

"So, hey, uh-whats-yer-name, Phil?" Jet asked.

"Bill." Bill picked up a few feathers that Jet had shed in his fit yesterday. He turned to face him.

"Bill, yeah, right." Jet had been craning his little green head around to look at Bill. Keeping eye contact, Jet stepped around on his swing so that his whole body faced him. "Say, uh, do me a favor, would ya?"

Bill hesitated only a moment, then said, "Sure. What can I do?"

"Well, uh, would ya mind playing some music for me? I got a bunch of CDs over there by the player." Jet flew over to the ancient CD player. Bill walked over and saw the collection of music, some of it classical, dating back to the '60s and '70s. There were a lot of names he'd never heard of before. By far, though, the majority of the CDs were by Blitzkrieg, the F-15s and Stealth. These were all Jet's bands from his years as a working musician. He had some solo stuff too. A small memcube player sat beside the CD player, but there were far fewer cubes to select from.

"So what do you want to hear?" Bill asked.

"Ya know how ya get a certain song stuck in yer head and ya just gotta hear it or ya'll go bonkers? Huh?"

"Yeah, I know how it is," Bill nodded.

"Yeah, well, I gotta hear this one." Jet reached up with his beak, and tugged at a CD from the Blitzkrieg section. Bill pulled it out of the rack and read the title.

"*Necrotic Nuisance?*"

"That's the one. It went Uranium five times." Jet cocked his head to the right in appreciation.

Bill tried studying the CD player to figure out how it worked, but Jet shot orders at him too fast.

"On-button is there, lower left. Push the open/close button, just once. There, now put the disk in—NO NO!—Writing side up! Yeah, right. Now the open/close button again. Good. I really just wanted to hear one song. 'Teenage Angst.' So push the up-button 'til the display reads five. Right. Jeez, I need to get a system set up so *I* can do this. Shit. I just need to get a real body. Shit. Okay, now hit memory, then the play-button. That's the one with the single right hand arrow, okay?"

Bill smiled to himself and complied with all of Jet's directions. The room filled with the sound of loud distorted guitars and machine-gun-fire drumming. It pounded its way to the very core of Bill's body, and he wondered if Jet, being so much smaller, felt it even more intensely. Bill worried briefly about the volume, but decided not to turn it down unless told to. It seemed right to be this loud. Screaming vocals bounced eerily around them, first from the left, then behind, somehow jumping to the opposite corner, finally dopplering from below past their heads toward the infinity of

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up. Even though Bill couldn't have heard it, he was certain that Jet was singing along. He watched as Jet danced, hopping around on one leg then the other.

The song ended and the resulting quiet was almost as deafening as the music had been. After a moment of profound ecstasy, Bill turned to Jet and said, "Wow! That was great!"

Jet ducked his head a little and said, "Thanks." After another moment, he said, "Uh, you can put somethin' else on if you want. Just don't play anythin' real crappy, okay?"

"Okay," Bill said then wondered just what the guy's definition of crappy was. He played it safe, and started *Necrotic Nuisance* over from the beginning.

Even after Jet's attempt at peacemaking, Bill wondered each morning if he'd still have a job serving Jet Black. He was never sure if he could get through an hour without calling down the wrath of the old rocker.

Sometimes Jet would lash out at Bill for no apparent reason at all. Other times, he seemed to be very calculating in his attacks, as though he wanted to push Bill's buttons and start an argument merely for the sake of arguing.

Yet there were whole days when the parrot would be eager just to have Bill's company. He'd ask Bill about all the things any young adult male human would be interested in. Even then, though, Jet had strong opinions and one of his strongest opinions was that everyone should know what Jet's opinions were.

"So you're saving to buy yourself a mag," Jet said one sunny afternoon. "Have you looked at a bunch?"

"Well, yeah," Bill said, "I have my eye on—"

"No, wait. Let me guess," he said. "You want a Penex 1000, Candy Apple Red with all the latest laser trim and a friggin' top-of-the-line holo memcube player. 'Cept you'd probably play that twink crap that passes fer music now. Never mind that, Billyboy, I think the Penex is the mag fer you."

"Actually, I've been pricing an Izuda Flash—"

"A Flash? Are you friggin' crazy? They're nowhere, kid."

"Hey, they aren't *that* bad. Besides, I figure I can afford the down payment for one by next summer," Bill said, a defensive edge creeping into his voice.

"Yeah, sure. Ya might be able to *afford* a Flash, but deep down, don't ya really *want* a Penex? They're fast, they're powerful, and fems fall all over themselves ta ride in one."

"I can't argue about that, but I still can't afford one, and right now, I've just got to be realistic."

"Look, kid, I'm not sayin' yer wrong. Sometimes ya gotta be realistic. Maybe if I'da been more realistic I wouldn't be in this mess. But I *am* sayin' don't be denyin' yerself the pleasure of wantin' somethin' all the way."

"Okay," Bill said, "so what kind of mag do *you* have?"

Jet squawked once and ruffled his feathers. Uh-oh, Bill thought, now what?

"Whadya mean, what kinda mag do I have? Does it look like I have a mag? What the hell do ya think I'd do with a mag? I'm a freakin' bird! I can't reach the pedals fer chrissakes! An' ferget about gettin' a license. Awwkk! An' where'd I go? Aw hell, man." This turned out to be one of Jet's milder explosions. He didn't even leave the beam he'd been perched on. It still left Bill a little unsettled, though.

"I'm sorry, Mr. Black. I guess I thought that you'd have one in storage," Bill apologized.

"Let's get one thing straight here," Jet said. He flicked his wings to unruffle his feathers and walked to the end of the beam closest to Bill. "The *only* thing I have in storage is my body. It's on ice and it's a real möbius strip because I need enough money ta get a clone, but I need the clone fer the tour ta make the

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money. Or I need the doofuses at the research labs to find a cure for my original body. Ain't nobody's gonna pay ta hear a parrot sing. In the meantime, here I sit. Molting."

"I thought you guys sounded pretty good tonight," Bill said. He sat with Diane on her couch, sharing a pint of strawberry swirl ice cream with her.

"Hmm, it was okay, I guess," she said. She dipped her spoon into the carton and dug out a frozen berry. "Thanks for the ice cream. It gets hot up on stage." She stuck the berry, spoon and all, into her mouth, then held the spoon with her lips while she pulled her damp hair away from her neck.

"You're welcome," Bill said. "You don't sound very up about the practice."

"CJ's drumming was off tonight. She kept rushing the beat, like she had somewhere else to go."

Bill licked his spoon clean and said, "My client said he had the worst time trying to find a drummer who didn't do that. He said it's like they're all in a big race or something."

"You seem to be getting along pretty well with your client these days," she said. "What's it been, three weeks now?"

"Yeah, I guess it has."

"Not bad for someone who was sure he wouldn't last another day with the guy." She waited for her turn at the ice cream. "What did you think of the last song we did?"

"The new one? Pretty good. It'll be a knockout once you guys get the chord progressions down."

Bill knew right away that he'd blown it. Every time Diane gave him *that* look—the one where she stared at him, waiting for him to say, "Just kidding"—he was in trouble.

"Oh, great," she said at last, her meaning clear that it wasn't great. "The chord progressions are the only thing *right* with that song. I'm never going to get enough new material for another demo at this rate. I may have to resort to doing a cover of 'Free Bird'," she snorted in disgust.

"Come on, Diane. I'm not a musician; what do I know about chord progressions?" Bill didn't want this evening to go sour. Diane worked hard to get her band out of the garage and into the studio, but her ego had taken a hit with this last rejection. She'd been pretty glum lately.

"Well, you know enough to know what I already knew, too. That song isn't right, for whatever reason." She scraped the last of the ice cream out of the carton and licked the spoon clean. "I just wish there was someone else I could send the demo to, keep it out while we work on more songs."

"I wish I could help you," Bill said.

"Yeah, me too."

They sat in silence for a while, staring at the empty ice cream carton. "Billy," Diane said, her voice soft.

"Yeah?"

"You said your client has a memcube player—"

"No way, Diane!" Bill sat up straight.

"Aww, come on. You said he sometimes lets you pick the music to play."

"No!"

She looked at him and blinked her long eyelashes at him. "Please?"

"Aww jeez! Bill! What the friggin' hell ya tryin' ta do ta me!" Jet flapped his wings furiously at the memcube player. "Bill! Turn this drivel off! Now! Damn it. Aaawwkkk!"

"Shhh, hold on." Bill had been afraid of this. He still couldn't believe that he'd let Diane talk him into playing her demo for his "mystery client." He managed to push Jet out of his way enough to turn off the player. He took the clear crystaliine cube out and was going to pocket it, but before he could, Jet flew past and caught it in his beak.

With more grace than Bill could imagine, Jet landed on a shelf on the opposite side of the room and set the mem-

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cube between his feet. "We need to talk," Jet said. Bill felt like Jet had bored a hole all the way through his head with those parrot eyes of his. There'd be no excuses here.

Bill turned to face him straight on. "Okay." What else could he say?

"Where'd ya get this?" Jet asked. He rolled the cube between his toes.

"It's not mine. It belongs to a friend."

"Your girlfriend, huh?"

This took Bill by surprise. "How'd you know?"

"Hey, hey, hey. I'm askin' the questions here. It's a demo, right?"

"Yes."

"It's her first demo, but she's working on another."

"Yes."

"Jeez, ya stopped the player just in time. She probably does some stinkin' cover of 'Free Bird,' and I *really* freakin' hate that song, now more than ever," Jet muttered. He turned back to Bill. "So ya offered ta take it ta good ol' Jet Black. 'He's a rocker. I'll bet he's got lotsa connections, yeah. An' he's got nuthin' better ta do than scout out new bands. I'll just do ol' Jet Black a favor an' let him discover my girlfriend's band.' Well let me tell ya this, Billyboy, I ain't gonna discover yer squeeze's freakin' band cuz I can't do a freakin' thing about it. Damn, I can't even get my *own* songs recorded. I've got ten CDs worth of songs that *I* can't do anything with. I can't do a damn thing about her band even if I *thought* they had a friggin' chance." Jet picked up the memcube in his beak again and with one quick bite, shattered it. Spitting the pieces out, he said, "That's what I think of yer girlfriend's friggin' demo."

Bill and Jet stared at each other for a long moment. Bill turned away and headed for the hall.

"Where ya goin'?" Jet asked.

"To clean up the mess. It's in the carpet, now, so I'll have to vacuum."

"Aww, Jeezus . . . Hey! Leave it until my freakin' afternoon exercises, would ya? Aaawwwk! Oh, shit!"

"He crushed my demo?" Diane asked. Bill could tell she was hoping he was teasing her.

In answer, he handed her the sandwich bag with the shards of the memcube in it. Then he leaned against the refrigerator in her tiny apartment.

"Shit."

Bill thought he'd better not tell Diane that Jet said the same thing about it.

"Who does this jerk think he is?" She was somewhere between mad and crying. Bill hadn't seen her this upset in years. Not since their sixth grade teacher found Diane's love letter to Danny Greenbaum and decided to read it aloud to the class, complete with lyrics from a Rhesus Monkey song.

"Diane, I'm so sorry," Bill said.

"Bill," she said, tears rimming her eyes, "now what am I going to do?"

"Come on, Diane. You said everybody'd already heard this demo. Chalk it up to practice and you and the gang go in and make the next one."

"You make it sound so easy," she said between snuffles. "Don't you think I've been trying? We need new material, and I'm the only one who really knows how to orchestrate. And, and . . ." Her lower lip was quivering and her nose and eyes were turning red.

Bill grabbed a tissue for her. It made him feel a little less useless. She quickly dabbed at her eyes and blew her nose and snuffled once more before she continued.

"And even if we *did* have more songs to record, the demo studio costs money and Frank doesn't work there anymore. Did I tell you he got fired? And so he can't get us discounts anymore or barter his time, and and and . . . *hic* and *hic wahhhhhhhh!!!*"

Bill had *never* seen Diane lose it like this! Crying herself to hiccups. He cradled her in his arms, her face buried in his chest, and he cooed softly.

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"Shhhh, now, it's okay. It's okay," he said. The fresh smell of her hair was starting to intoxicate him.

"No, it's *not* okay," she said. Most of her words were muffled in his shirt, but he knew what she'd said. Her breath was hot against him. It felt kind of nice.

"Sure it is. We'll think of something."

"Oh, Bill, I don't know what."

"I'm sorry, Di. I shoulda known old Jet would do something rude like—"

"What?" Diane asked suddenly. She pulled back from Bill and somehow her tears dried up, though her face was still red and her eyes a little puffy.

"What?" Bill asked.

"O my God! I can't believe it!"

"What!?"

"Your mystery client is Jet Black, isn't it! No, no. Don't tell me. I don't want you to break your confident patient thing. God!" Diane stood back from Bill a little, and gave him an embarrassed smile. Then she turned away, blew her nose and touched the wreckage of her memcube with wonder.

"Bill! *Jet Black* crushed my demo! I thought he was dead!" Her eyes were shining with excitement. Bill worried that she was cracking up from the strain.

"Don't you get it, Bill?" Her bright eyes looked up at him, searching his face for a clue that he *did* get it. But he had no clue to give her.

"You've been slacking on your rock history, man. Don't you know just who it is you're dealing with? Jet Black, hard-rocking, hard-living, hard-to-live-with leader of the F-15s and Stealth—"

"Don't forget Blitzkreig," he added.

"Yes, Blitzkreig. Jet Black is this century's Mozart. A genius who walks the fine line of sanity."

"I *have* heard some his work. It's good."

"Good? It's wonderful. *Brilliant*. Words can't describe his music. Bill! You're taking care of a legend!"

"Great," he said without enthusiasm. "It was hard enough to deal with your basic musician. Now he's legend."

"Get with it, Bill. He's alive! All this time everyone thought he was dead." She sat down on the couch.

"So how'd he supposedly die?" Bill sat down beside her.

"For a long time, everyone thought he'd died the way most rockers do. Overdose or something related," she paused to blow her nose, "but then someone from the F-15s let it slip that he was diagnosed with myelonecrotic hypersomethingorother. Whatever it was, it was incurable and fatal and he supposedly died from it."

"But he didn't! At least his soul, or whatever you want to call it, didn't," Bill said. "He's sitting in a parrot body as we speak, down at the aviary."

She hugged herself tightly. "I can't believe it!"

"Believe it," Bill said. "So how long ago did he, uh, die?"

"Oh, let me think. It must've been at least twenty-five years ago."

"Yeesch. No wonder he's crabby. He's been in that parrot for all this time."

"Why doesn't he just get a clone made?"

"He has his reasons."

Diane asked, "Oh?" hoping for more explanation.

"Patient confidentiality, again," he said. "I don't want to make this any more complicated than it already is. But you can fill me in on him, can't you?"

"I can tell you about his albums, awards, lawsuits, lovers. Whatever you want."

"Lovers?"

"Oh yes! Especially Jazzmin—"

"How about a cup of tea or something and you can catch me up on my Jet Black history."

"Sure. Want a dry shirt while we talk? I'm afraid I got yours all soggy."

Bill looked down at his shirt. "Well, okay."

"Hey Jet," Bill said, "what do you want more than anything else?"

"Don't be toyin' with me, kid. Ya

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know freakin' well what I want more than anything else." Jet was biting at a string of crystals that glittered in the sun.

"Yeah, I know," Bill said. "You want out of the parrot body. How're you going to do it?"

"I'm warning ya, leave it alone." Jet's tone of voice went from being simply annoyed to threatening.

"I'm serious, Jet. I think I know what to do. I know we can't get your original body cured yet, but I—"

"Aawwwk! What're ya friggin' talkin' about, Bill?!"

"Hear me out. Just because Jazzmin—"

"Stop! Don't be sayin' her name around here—"

"Jazzmin? Your ex?"

Jet started squawking and screaming and shouting "Stop it!" at the most furious rate Bill had seen yet. He'd expected to get some kind of reaction out of Jet by mentioning his ex-lover's name but this was far better than he'd expected. He just hoped that his plan didn't backfire on him. Bill kept egging him on, calling out Jazzmin's name, until Jet had littered the floor with green and blue feathers. Jet tried dive-bombing Bill and snapping at his ears with his beak. He beat at Bill with his wings, and then Bill brought out the heavy artillery: the vacuum cleaner. One flick of the switch and the vacuum roared to life. Bill heard Jet's piercing "NO" above the din.

Jet retreated to a dark corner shelf, trembling with exertion. Bill took a couple of quick runs on the carpet while he had the vacuum going, just for good measure, then flicked it off.

Jet was quiet now and Bill noticed that he looked like a feather duster that the cat had played with too long. He tucked his head under his wing and muttered, "Go away."

Bill felt almost as exhausted as Jet looked. It was a big chance he was taking and it could cost him his job. He dimmed the rest of the lights and said, "I'm sorry, Jet. But this is the only way I knew you'd hear me out. You're too tired to object."

There was a knock at the door. Bill opened it just a crack to see Ms. Chan on the other side, concern written all over her face.

"What is *happening* in there?" she asked in a harsh whisper.

"It's okay, Ms. Chan. I have everything under control." *Yeah, right.*

"You better. Some of our other clients are very upset by the racket coming out of there. If I hear any more commotion out of there like that, I may have to find someone else to look after Mr. Black. Heaven help us." She closed the door.

"You hear her, Jet?" Bill asked. "We may have lost me my job. But I still want you to hear me out."

"Like I seem ta have a choice," Jet said. His trembling was less violent. "So lay it on me."

"What? This is her?" Jet gave Diane the once over, flapping from one perch to another to get a full view of her. "Look, sweetie, no offense, but you just ain't the picture of success. Not in rock."

Diane's eyes grew huge and her mouth dropped, but she recovered quickly.

"You haven't even heard me yet!" she said.

"Yeah, and I don't have ta. You gotta drop five to ten pounds right off, or move 'em up from yer lower half ta yer uppa half, if ya get my drift. Look, I know what I'm talkin' about."

"Okay, five to ten pounds off, not up," Diane said defiantly.

"And what's with the hair? What, the cocker spaniel look is in? I think not! Awk, I mean, aw hell. We'll deal with that later. So sweetie, let's hear yer pipes."

Bill saw Diane's face go pale. He knew she was nervous, but didn't realize how bad until he noticed how white her knuckles were as she gripped her guitar. With a deep breath, she switched on her

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amp and let loose with the best she had. Jet sat silently through the audition then announced his verdict.

"What the hell do ya call that? A song? You don't know the difference between a bar and a bridge, a coda from a coma and if ya play that kinda crap to an audience that's what they'll be in, a coma! Jeezus, and those lyrics! I hardly dare call 'em that! Who in the world told ya you could write a song!" Jet paced back and forth during this diatribe, flapping his wings as he went.

Bill watched the whole scene from the corner of the room, holding his breath as though that could give Diane the extra support she needed. He could see she was trembling.

"But!" Jet cackled, "Ya do have a passable voice—"

"You really think so?" Diane asked.

"Hey, I'm talkin' here," Jet said. The room went instantly silent and Diana's lips were clamped shut, with a subtle hint of a smile playing at the corners of her mouth.

He laughed, a squeaky kind of sound, and continued, "—and in time I think we can work on yer guitar technique. Between the two of us we may have a chance."

Diane's eyes were wide and her smile even wider. "Bill! Did you hear that?" she laughed. "He said my voice is passable! Jet Black said that about *me*!"

Bill smiled. "Yes, I heard."

"Here's the deal," Jet said, "My songs, your voice. A first album's always sorta risky, but we can split the take sixty-forty. Since it's my songs and my connections, I get the sixty. Of course, anything left over from paying off my new clone goes for the headhunter's fee, right, Bill?"

"Huh?" Bill asked. "Headhunter's fee?" The conversation was streaking right past him now.

"Sure thing. Should be enough ta pay fer that Candy Apple Penex, doncha think?"

"What? Now wait a minute—"

Diane shot him a questioning look that plainly said, *Since when have you wanted a Penex?*

Bill shrugged back.

Jet didn't notice this exchange. "Aw, Jeez," he said, "if we're gonna haggle, yer gonna have ta break out my special Colombian, man."

"I'm not—"

"The Colombian!" the parrot demanded.

Mystified, Bill got the bag of seed and poured a handful into Jet's feeder. "All right?" he asked.

"Perfect," Jet said, "Gawd, I love talking business over lunch." ■

No new findings will ever be made if we rest content with the findings of the past. Besides, a man who follows someone else not only doesn't find anything, he is not even looking. "But surely you are going to walk in your predecessors' footsteps?" Yes indeed, I shall use the old road, but if I find a shorter and easier one I shall open it up. The men who pioneered the old routes are leaders, not our masters. Truth lies open to everyone. There has yet to be a monopoly of truth. And there is plenty of it left for future generations too.

— Seneca (4 BC - AD 65)(Submitted by Ted Truscoe)

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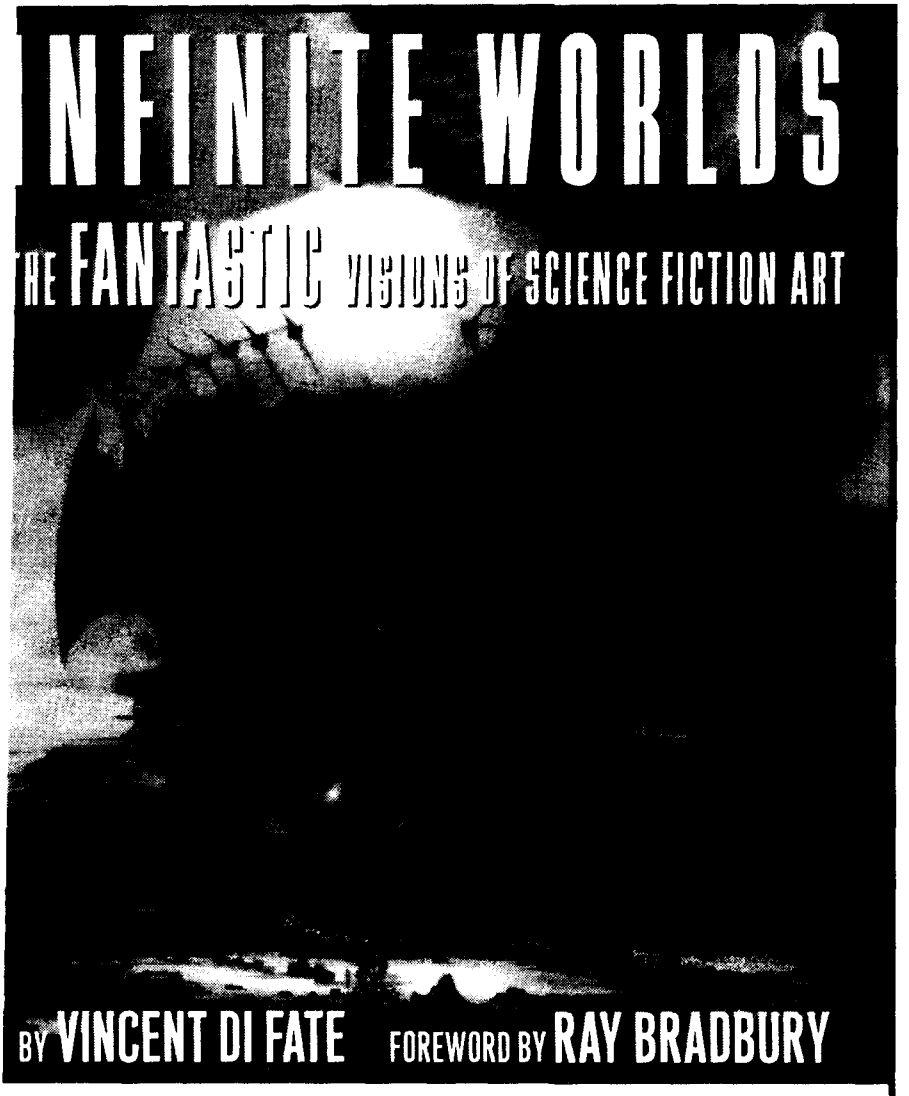

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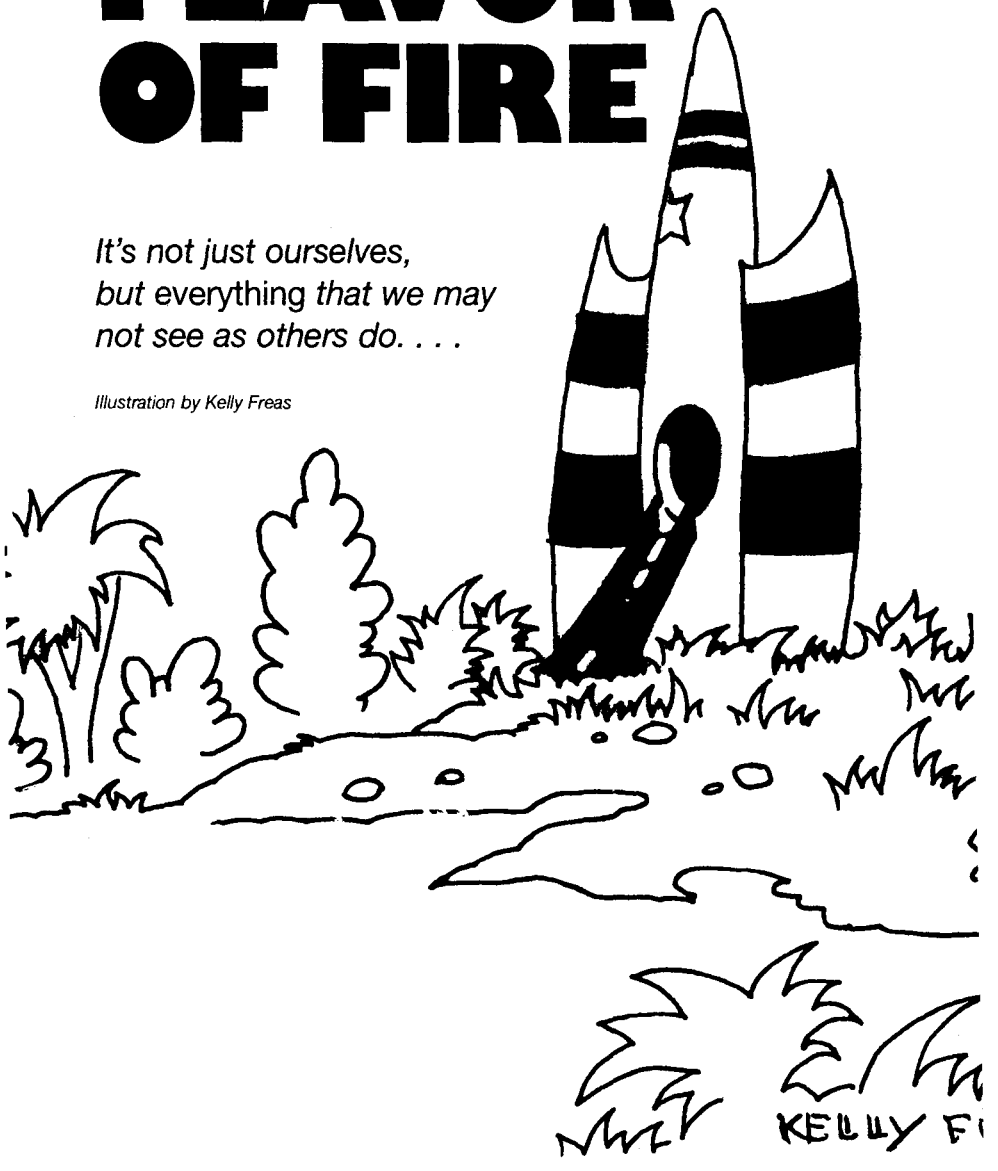
Ramona Louise Wheeler

THE FLAVOR OF FIRE

It's not just ourselves,
but everything *that we may*
not see as others do. . . .

Illustration by Kelly Freas



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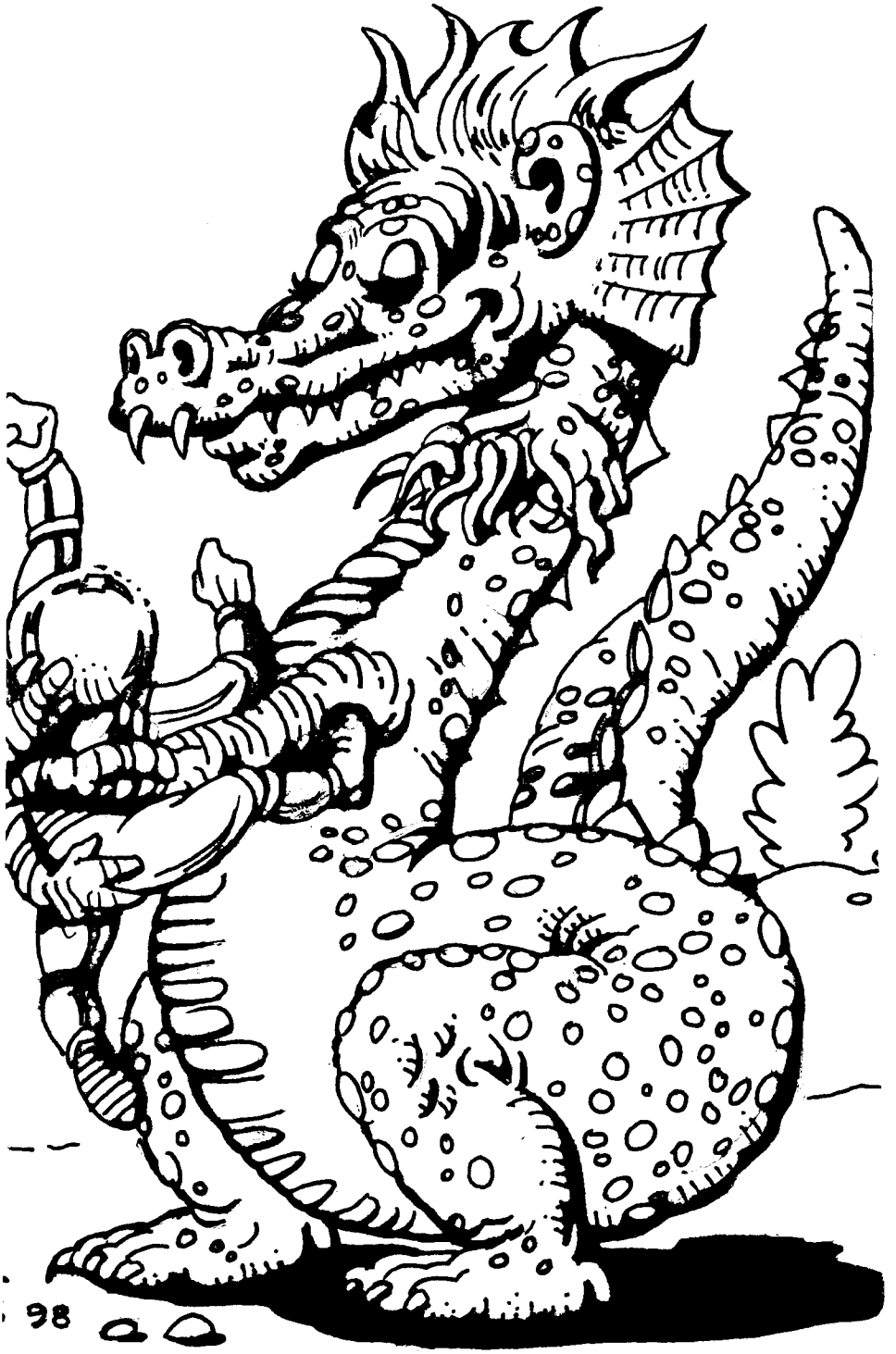

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One

Folobolos of Bodo saw a new god-being.

The new god-being emerged from its great white private temple to stand on the stony hard ground that surrounded the Temple of the Swinbrok. Folobolos knew that it was a god-being. The white temple it had traveled in was radiating the divine yumm-yumm energy. The patterns were new in Folobolos' receivers, and powerful.

Folobolos wanted to be closer. He slither-crept along the edge of the Dry Place of Swinbrok, half in the water so that he could sink out of sight if he must.

The god-being was golden and glorious. It glittered in the sunlight of that sacred ground. Folobolos crept closer still, slick with fear and excitement, until he trembled with the closeness of it. The divine yumm-yumm energy rang through him entirely.

The golden god-being stood beside the curved, white wall of its temple, in rapport with that and thus unaware of Folobolos creeping up in reverence and stealth. Folobolos surged up from the water, balancing the leap with his outflung tail, and he snatched up the god-being. He clasped it to his breast with all his love-tentacles and both pair of hands. The god-being made the ritual gesture of attempting escape, signaling to Folobolos its desire to be captured and held and absorbed. Folobolos' joy buzzed through his flesh. He pressed the golden being close to his breast until its ritual struggles ceased and it fell limp, surrendering its blessing to him. He escaped from the Dry Place with the god-being held tenderly in his love-tentacles. He swished directly through the marsh edgings and into the sacred waterways that would lead him to his own temple and his secret altar there. He knew he had done what the god-being wanted, because the divine yumm-yumm pursued him through the marsh and the waterways. Even though fainter, the magical newness of the signal buzzed in his brain and his flesh, tickling every thrill-nerve in his spine out to the very tip of his tail.

Inside the three walls of his hidden temple, Folobolos gently placed the golden god-being on the woven-bone cradle of the altar. Each bone of the intricate altar was the bone of an ancestor, and each of these bones, as they cradled the god-being, would sing of the greatness of the greatest child of Bodo, of Folobolos who must be King. He would be King. Folobolos was certain of it now. All of the People would recognize his power, because he had captured this golden god-being. They would choose the best women for him, but he would choose Rhopalura, and only Rhopalura, no matter whom they offered him. The People would learn that Rhopalura belonged to him and to him alone. Folobolos settled back on his tail, and he watched his captive god, lying on his altar. He dreamed of the joy he would feel as he smashed and ate the eggs Rhopalura had been forced to produce for Fascinola, who was King now but who would not be King for long. The god-being did not stir, although the divine yumm-yumm continued to buzz in Folobolos' head, warming his many antennae. Folobolos did not worry. He had as much patience as a god-being. Had he not captured one? He would wait until the god-being was ready to speak, until the god-being announced to the People that Folobolos was King over all.

Two

As Wozurns go, Lord Rokhmyr, known now only as "Rokey," was on the small side, standing a mere six feet tall in his bare toes, weighing in at only five hundred pounds, most of which, of course, was his glorious coat of fur. The Wozurn pelt, pride of the race, had a range of colors. Rokey's fur was black, with lighter smudges on his face and hands. He was perfectly groomed and combed. Wozurns are always perfectly

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groomed and combed. His fine, broad shoulders and powerful arms gave him a rough outline, but the sensitive lines of his sculpted mouth and copper-colored eyes were noble and showed a gentle spirit. He was calm and patient, as men of such physical bulk often are, and he also had the patience of understanding. Rokey was very well educated. He could take a man's head off if it needed doing, but he would talk to the man first—explain his options to him.

By the looks of the man who had brought the Wozurn and his partner so far across space to solve a problem, Rokey might have to do a lot of explaining. This ancient cowboy had a stubborn kind of patience of his own. "Lord Rokhmyr, make yourself comfortable," Sam Swinbrok said. Sam Swinbrok owned Bodo, owned a whole world.

"I'd be much more comfortable without the title," Rokey said as he sat down on the oversized couch to which the man had directed him. "You never know who might be listening."

"I assure you, Lord—that is—Rokey, that our privacy here is complete," Sam Swinbrok said. "I pay a lot of money to be sure of that. We have as much need for obscurity as you do. That is why Mr. Humphrees suggested that you were the man to solve our little problem. Discretion. *You* cannot afford to have *your* expertise in this matter advertised, and *we* can't afford to have *our* little problem advertised."

"I'm pleased to hear that a native uprising is only a little problem."

Swinbrok's grin was quick, nervous, incomplete. "With your help, this uprising, as you call it, will be just a minor disturbance."

Rokey smelled the kind of fear-sweat that went with big problems that did not go away. The leathery, aging Terran was afraid, not trembling, heart-pounding afraid, but steadily, helplessly afraid—afraid all the way to his core. He was not afraid of the natives, not afraid of dying, he was afraid of something so unknown and different that his bones were weakening inside of him. Rokey could smell all this on him, with a Wozurn nose keener than the wildest wolf, but he said nothing, waiting while the old man settled himself in his own chair.

Sam Swinbrok was elaborately dressed like a cowboy. Rokey doubted that the hat, chaps, spurs, and silver fittings could be squeezed into a skinsuit, which meant the man did not go out on the planet's surface to work like a cowboy. Rokey did not assume, however, that the pearl-handled six-shooter was only for show. Men like Swinbrok really did try to act like cowboys.

Swinbrok rubbed his palms nervously as he leaned forward, resting his elbows on his thigh. "Do you like dinosaurs, Lord—uh, Rokey?"

"Everyone likes dinosaurs."

Swinbrok reached up and resettled his black cowboy hat so that more of his weathered face showed. The light from the picture window made a dense relief map of the lines in his ancient face. "My family has been exporting dinosaur products from this ranch for seven generations. I don't want my grandson to be the last."

"There are other planets with excess dinosaurs."

Swinbrok nodded slowly. His black eyes were intense, hiding that awful fear. "But I don't own any of 'em. I own this planet, and I aim to keep it."

"I thought the natives owned Bodo," Rokey said casually. "They evolved here, after all."

Swinbrok nodded again. "But they wouldn't have anything without us. The glaciers have everything but this single continent locked up and the natives can't compete with the dinosaurs here without our help. So we kind of mutually own the place with them."

Rokey thought that was probably a rationalization of the real situation. He kept that thought to himself. "My expertise, as you call it," he said instead, "is

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not in the line of dinosaurs. Mr. Humphrees may have exaggerated my usefulness to you."

It would be just like George Humphrees to do that.

Swinbrok licked his upper lip quickly. "I don't think so. You're the best expert on movies in all civilization, and I need an expert on movies."

"That is me," Rokey said evenly. He could not fathom a connection, yet the man seemed genuinely serious. Rokey folded his big arms across his chest. "But I don't get it."

Swinbrok made that nervous gesture of resettling his hat. Rokey could smell the rise in tension. "You see, these natives, they're radio people. I mean, they've got radio-biology, natural radio receivers." He paused, uneasy with his choice of words.

Rokey's blunt-tipped ears swiveled forward, but he had heard correctly. "Radio-biology?" he asked.

"They hunt with electrical signals, with biological EM-band receivers, all the way up to the radio range."

Sam Swinbrok had big hands, long hands with once-powerful fingers. Now, his knuckles were twisted and the skin was transparent, thin white paper over old bones. His hands fluttered, as though he could no longer hold on to the reins of his world. "I'm not used to explaining this, Rokey," he said finally. "We have our own words for all this, corral jargon, but they don't explain. We don't really know how it works, or why the natives like the broadcasts so much. We've never been allowed to dissect one and find out. We've used radio to talk to them since the first Swinbrok got here, over two hundred years ago. We don't know how they convert our signals to information, but they can, they enjoy it, and it's worked for seven generations."

"Do they broadcast as well?" Rokey asked.

Swinbrok shook his head. "Only by touch. That's why they work for us. They think we're special, 'cause we can broadcast without touch, like lightning storms, and electrical trees."

Rokey sighed slowly. "I see."

"We've been paying them for the dino eggs with radio broadcasts. All they want is entertainment. For five generations, all they wanted was music, but fifty years ago they started picking up the video signal from outbranch monitors. After that, they wanted video entertainment. They brought us twice as many eggs, seemed real happy with the stuff we showed them, but things suddenly exploded. They've gone to war with each other. I've lost a half dozen hands, my four best women among them." He sighed. "I can't let it get bigger."

Rokey hated to admit it, but Swinbrok had him. Rokey was an expert on "movies." He was a most educated expert on Hollywood mythology. The fact that he was currently in exile, hiding out as first mate on a private starship-freighter, was a mere technicality. As "Lord Rokhmyr" of Wozur, he had been head of the greatest university in all interstellar civilization. He had taught generations in the subtleties of Hollywood. Now he only watched movies in his starship quarters, and only occasionally tried to explain things to his young partner, Raymond Harris.

Rokey was suddenly eager for a new audience. "How is payment worked out?" he said.

"We broadcast 'round the clock during egg-collecting season, but at low power, so the range is limited. Anyone bringing eggs in is allowed to sit close to the broadcast tower. They had parties there, brought the kids to listen. Used to be that was enough."

"Where do things stand at this moment?"

Swinbrok sat gazing out to the mist that swirled around the Ranch dome. "We've just started collecting the first batch of walker eggs. Collection varies by a day or two every season, depending on the humidity, but the first broadcasts

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started a couple of days ago. You got here just in time."

"Maybe," Rokey said thoughtfully. "Maybe."

"I've laid in a weapons supply," Swinbrok said quietly, as though, despite his promise of privacy, someone might hear. "Projectile guns, since neural stunguns just make them horny. I don't want to go that way, except to keep my people alive. If we start shooting—well, seven generations of good relations can't be won back in one lifetime, certainly not in my lifetime."

Rokey looked at that pearl-handled gun, realized again that it really was a six-shooter. Cowboys. He wondered what the real problem was—the obvious, overlooked something that was the root cause. But that was why he had been hired, to find that out. Sometimes only an expert can see the obvious. "Who knows the most about the natives, about the Bodoites themselves?"

Swinbrok looked embarrassed, and shifted his hat again. "That'd be my wife, Dr. Bailey. She came here originally to study the Bodoites, as a graduate student in exobiology. She's the expert in the family. She's the one who got Bolinop to agree to talk with you."

"Bolinop?"

"He's the native big-man. Well, I guess you'd call him their chief scientist, or shaman. Their society is complicated and primitive at the same time."

Rokey recognized the pattern of titles at once. "Bolinop."

"He's arranged to get together with you at midnight tonight." Swinbrok said this as though he were apologizing. "Can you manage that?"

"Why midnight?"

"Bolinop insists. He's got a thing about keeping his business secret from his people. Gives more mana to the stuff he does."

Rokey chuckled. "And makes his magic tricks look like real magic."

Swinbrok agreed. "He's got the most powerful mana of his people."

"Midnight it is, then, I wouldn't want to offend his mana." Rokey tried to sit up straighter in the overly comfortable couch-cushions. "Meanwhile, I should talk to your wife."

"Yes." Some sad shadow brushed Swinbrok's face, half-hidden by the tilt of his hat brim. "She's down at the labs. I guess she is, anyway. You ask my son, Daniel. I'll send him up. He'll know where she is just now."

Rokey made no comment, but he saw how the pale window light outlined the old man's face with pain-shapes, making him suddenly small and tired inside his gaudy cowboy costume.

"I'll send Daniel up right away, Lord—uh, Rokey. He can tell you more. I just wanted—well, I needed to know you were willing to help us."

"I'll do the best I can." Even if only to satisfy his own curiosity.

Swinbrok stood up, pushing himself out of his chair with his big, tired hands. "Daniel will be up here in a minute. Shall I have him bring you some coffee, or a drink?"

"One of each," Rokey said pleasantly. "Mixed any way you like."

Swinbrok smiled. "Dan, he'll do you up fine, sir. Fine, indeed."

He stood gracelessly, and Rokey understood how old a man he was, ancient, shriveled, held together with string and spit and stubbornness. The cracks across his face were the glazing of centuries, and his cowboy duds hung upon him like a loose skin. Rokey was, himself, an old man. He would live to be older still, but he respected age. Swinbrok and Rokey were actually of similar age in Sun-years, but Rokey had been born under a different Sun. He was still in the first quarter of his life span. Swinbrok was not. He was old, measuring the life left to him in months and weeks. Rokey thought about that while he watched the ancient cowboy swagger out with slow-motion pride.

Rokey thought about dinosaurs and radio waves and video signals, and about

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cowboys carefully tending giant eggs in swamp nests. He thought a lot about native Bodoites watching movies in deep jungle theaters. What did they perceive? What does a living brain make of direct radio signals? Rokey had just concluded that the only thing he really had to work with was the fact that they *did* enjoy the signals, whatever they made of them, when Swinbrok's son, Daniel, interrupted this mental exploration. "Good evening, sir."

Daniel was a sad, thin ghost of his ancient father, not young, not old, not dark, not light, not tall, not short, not smiling, sad, or serious; smooth of face and manner, smooth of voice, gliding over the terra-cotta tiles with a sinuous, smooth motion. He was not dressed like a cowboy, although his finely tailored black suit was of denim. He set a tray down on the end table beside Rokey as he introduced himself, welcoming Rokey to their "little family problem."

"Your father called it a minor disturbance."

"It is a disturbing problem, sir," Daniel said smoothly. "Our entire family is disturbed by it one way or another." He poured and mixed deftly as he spoke, presenting Rokey with a hot and promising mug of wild coffee.

"You chose the video selections to broadcast to the Bodoites?" Rokey was guessing, but there was a smugness to the man that showed he was as frightened as his father.

"Yes, sir."

Was that defiance Rokey heard? It was too smoothly said to be certain, but Rokey's ears were capable of picking out the most subtle resonance.

Daniel leaned forward slightly, his thin lips parting just a bit. "I wanted visual impact, strong patterns that delivered coherent progressions of universal symbolism." He spoke crisply, caressing the syllables. A light touched him, an eagerness. "I selected a series that would give them a solid grounding in the jargon of the media, to enhance their appreciation as they watched over a course of years. I was aware that whole generations of Bodoites would be seeing these."

"That's a lot of responsibility. A whole race of people. For generations."

Daniel nodded, almost showing teeth in a smile.

Rokey realized with a twinge of dismay that this man did not understand the enormity of what he had started. Daniel Swinbrok believed utterly in his own good intentions. Rokey knew that there were few things more dangerous than half-informed good intentions. "Where did you study Hollywood?" Rokey asked after a moment.

Daniel shrugged, letting his pale gaze drift away from Rokey's face. "I read. A great deal. I watch a lot of movies."

Rokey wondered more about what Daniel had not read, some of which Rokey himself had written, a long time ago. "What did you show them?"

"Robin Hood. Machicho. The Chilam Balam. Bugs Are Normal. Trideum. Mechanical Horizon. The Wizard of Oz. Drinking in the Atmosphere. Tendaguru. The Chondrite Memorandum." He had the list memorized. He had been waiting, rehearsed.

As Daniel reeled off the other dozen or so titles, Rokey almost approved. He nodded gently as the list went on, but something made him uneasy, something he was missing. "And the most recent ones?"

Rokey recognized that list as well. He did not recognize a pattern that might start a war.

"I made certain they saw the very best editions, as well. These people are capable of much nuance in perception. I had to grandstand some to get Father to agree to spend for the best for them, to spend for a better broadcast system, but we owe them that, don't we? I mean, if we're going to be so important to them?"

Rokey wished suddenly that his partner, Ray Harris, were here listening in-

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stead of doing ship repairs. Ray was of the same race as the Swinbrok family, and he could read humans better than Rokey, and pick up their cues faster. He would know if this Daniel were just fooling himself, sincerely a fool, or merely eccentric. Rokey was a sucker for eccentrics, and trusted Ray's judgment on that the same way Ray trusted Rokey's nose. Ray had sharp green eyes that missed little. "Your father suggested I talk to your mother about the Bodoites themselves."

The question hung like bright ice in the air, and Rokey wondered.

"She should be down in the lab," Daniel said, standing up and turning to the tray he had brought in. "I'll just let her know we're on the way."

Three

Once back on board his starship, *Yankee Shadow*, Rokey slowly shed his skinsuit in the airlock, annoyed by the twist and pull of its plastic surfaces catching at his fur and disarranging it uncomfortably. He hung the suit up in the airlock storage panel, and punched in the commands for the airlock to triple-disinfect it ofany dangerous mold spores picked up while outside crossing from the Ranch dome to his ship. The atmosphere of Bodo was unbreathable and ripe with intrusive life.

Rokey was tired, and nearly stumbled over the loose kit bag which Dr. Bailey had given to him. The visit with her had been lengthy, and involved walking through the entire incubation and tanning operations in the warehouse-sized structure Swinbrok had called "the lab." Dr. Bailey called it her "nursery." Her devotion to the nestlings in her charge was quite savage. Rokey had been wearied as much by her intensity as the long walk.

Rokey was also annoyed that he had not seen his partner, Ray Harris, working on the worn shield elements that he had promised to replace. Rokey hoped that this meant the work was done, and not that it could *not* be done, but he knew his partner. It could mean almost anything. He did not want to ask these dino-cowboys for help. He was intrigued by their "little problem," but he had little confidence in their technique.

Ray was not in his quarters nor in the galley.

Rokey mixed himself a mug of liquid supper, needing nutrition, not food. He wondered why he could not smell anything like Ray. His nose usually told him where his partner was and most of what he was doing. Rokey's thinking was grounded in scent. His thoughts were often in smells rather than words, colors, or images. He was often immersed in only smell memories, smell thoughts, whole afternoons spent in wordless contemplation. Smell was a color in his mind, a world of smell-colors blended on a palette of memory, incomprehensible to image-thinking yet clear in his mind.

Rokey drained the mug without waiting to heat it.

Ray was not in the shower, not on the bridge, not in engineering. Rokey even checked in sickbay, even though he was certain Ray would not be there. Ray hated the automated hospital unit so fiercely that only dire blood loss would have forced him into it. Rokey would have smelled that instantly. Rokey had known from the moment the airlock opened that Ray was not on board. His nose knew. He had refused to accept the knowledge, and stubbornly paced through the ship. Ray was not on board and neither was the gold-coated skinsuit he had been wearing to go outside the ship.

Rokey went up to the bridge, and called up every visual scan the starship had of its own outer hull, all of which showed only the *Yankee Shadow's* clean white self glowing dimly in the clouded, watery light of late afternoon. He focused on the hull panel at which Ray had been working. It stood open, with the translucent photonic plates still partially raised out of their bubble-pack housings. Ray was gone.

Rokey felt weary and sick at heart.

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There had to be an easy, simple explanation. Ray would return any minute. Rokey already knew that this was not true, that his partner had gotten in trouble, bad trouble, somehow. Rokey had to find him.

He opened the comlink to the Swinbrok Ranch, and Swinbrok himself answered. He sounded angry, but quickly forced politeness into his voice when Rokey identified himself.

"My captain is missing," Rokey said. "Tall, thin fellow, Terran, blond. Wearing a goldtone skinsuit."

"This is bad territory for a man to wander out alone in," Swinbrok said in reply, after a long minute. "Especially in gold. We must have forgot to warn you about that. Was he drinking?"

Rokey thought back to watching Ray suit up to go out for this maintenance that had to be done before they could take off again. Ray had been angry, but not drunk. "No. He was working. Outside."

"I'll send some men out to look," Swinbrok radioed. "Was his suit good?"

Rokey frowned at the casual impertinence of ground dwellers. "Yes."

"Good. He'll need a decent suit here. This place will eat you alive if it can get in a crack."

"Find him," Rokey said quietly.

"Of course, Lord . . . of course, Rokey. I'll get the foreman herself on it."

When he had signed off, Rokey noticed that a single monitor indicator was powered on, showing that Ray's private music broadcaster was playing. He had set it to play work music at him, broadcast to his suit receiver from the dash. The program had just started over, a two-hour show. Rokey felt a dangerous surge of excitement and quickly settled back to his controls to cut into the broadcast and talk to Ray. "Cap'n, where the hell are you? Ray? Are you out there?"

Rokey's control systems and monitors could not tell him if Ray's suit radio was, somewhere, receiving the signal broadcast from the *Yankee Shadow*. They could not tell him why Ray was not answering. The static-ripped mists and electrically sizzling plant life produced too much interference for any tracking. Ray's here-I-am signal would be invisible, even if it were on. Rokey sat on the bridge and fumed at his own helplessness.

This planet had more than insidious mold spores and electric shocks. There were dinosaurs out there in the mists, animals that ate things for a living, animals for whom Raymond Harris in a gold-coated skinsuit would be only a brightly packaged snack.

Swinbrok's call came back too quickly. There was no sign of Ray anywhere on the Ranch grounds. "We'll keep looking," Swinbrok assured him. "We haven't had any of the big fellas come around this close to the Ranch. We keep tabs on the few that are left. I think we'd know if anything had gotten him. Can he swim?"

Rokey had to think hard. He could not remember ever seeing Ray close enough to any body of water bigger than a sauna. Ray did not put in much time on planets, doing planet things. He was a starman, a trucker, born and raised in the starlanes of the galaxy. "I'm sure he could get the hang of it if he had to," he answered finally.

"You sure he wasn't drinking?"

Rokey growled back an answer so curtly that Swinbrok, on the other end, began apologizing. "The Bodoites have been acting crazy, just crazy. This is the kind of thing that made me call in the Humphrees Agency for help. Equipment disappearing, crazy."

"I'll start working on your problem, Swinbrok. You just keep your men looking for my partner. Even if all I get back are his parts, I'm going to want to count the pieces."

"We've got Bolinop ready to meet with you, Rokey. Tonight."

Rokey could hear the anxious edge to Swinbrok's voice. "I'll be ready," he answered stiffly. Perhaps he could per-

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suade the native Bodoite to help in the search for Ray.

"My men will be along there about seven."

Four

Raymond Harris knew there was something wrong before he was even fully conscious. He lay very still as he awakened more. He was, at least, inside his skinsuit. Training from his youth made him check readouts on his faceplate before he looked at anything else. Nothing around him except the readout graphs made sense. He tried to focus on these as he pushed away panic, but all he could determine was that he was still alive, and he needed the readouts to be certain of that. He was completely numb everywhere that did not hurt. All he remembered was a searing jolt of raw electricity sizzling his senses through the gold-coated suit that was supposed to protect him. Was he dead?

Ray heard Rokey's voice again and realized with a jolt that he had awakened because Rokey was calling him. He tried to reach for his transmitter control, but his arms were so tightly wrapped that he could not feel his fingers or the fingertip knobs that activated his suit radio.

"Ray? Ray, you out there?"

Ray struggled.

Rokey's voice went on in his ear, worried, tired, annoyed. Ray wondered dizzily if he could talk even if he could get his suit transmitter turned on. "I know you're out there, Ray. Just hang on. We are looking for you. Just stay alive. We'll find you."

Ray worked on that, holding on to it. Rokey had saved him before. He would do it again, Ray was sure.

Five

The lake was placid. Rokey regretted the thought at once. He disliked the word "placid." It reminded him of milk, and he hated milk.

The lake waters lay flat and sullen beneath the rotten timbers of the dock, sucking at the moldering wood with soft snickers, sighing at the night wind. Rokey liked that better. The black waters were waiting, poised, plotting. Things half-alive stirred in its fetid depths. There was nothing here of milk.

The self-contained atmosphere of the skinsuit cut Rokey off from the night's fragrances, denying him contact with a world of smells. The aged, noisome wharf crawled with unseen, unscented, insensible life, yet to Rokey it was distant, like a poorly done documentary. All he could smell was himself and the inside of his suit. Even his copper-foil eyes were unable to see into the darkness here— there were only movements of black against blackness.

Thick mats of dead leaves muffled the slap of waves against the dock planks as the Bodoite boat approached. It rode without lights, slicing quietly through the black water. Mist-enshrouded stars glinted on the murky surface, revealing the boat only as ripples among dim reflections. It seemed enormous to Rokey in this darkly unreal place. A pair of dragons rode a wooden log over thick waters, dark shapes on darkness. The dock shook under him as they pulled up alongside.

Rokey recognized then the "two-man raft" as described by Swinbrok's wife. The craft itself was long and narrow, intricately carved, but still a glorified log. One Bodoite lay in the front, anchored somehow on the log but with his chest, forelimbs, and head submerged at the prow up to the curved nosetube. His huge bulbous eyes gleamed above the waterline like headlights. He was the navigator, guiding the raft with his radiomagnetic sensing systems in the tentacles, antennae, and forelimbs in the water. His long tail stretched out along the center of the craft, gripped by the love-tentacles of the pilot who stood at the rear. The pilot's tail dangled down into the water behind, braced by elaborate carvings in the wooden log, serving as a living rudder. His powerful hind legs

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hung down into the water on either side to paddle the raft along. The two thus sailed together as one, fore and aft, navigator and pilot, linked in complete communication by the contact of love-tentacles to tail sensors, nervous system to nervous system. The size of the boat was determined by this combination of body lengths. No two were the same.

Rokey remained standing on the dock, refusing to let alarm overtake him.

Dr. Bailey had assured him that nothing could sink these native-made craft. Rokey tried to believe, but his nerve was shaken when the pilot reached out with his powerful middle-arms and grabbed him. He was hoisted up into the night and laid flat on his back across the narrow raft. Rokey was abruptly disoriented as the pilot spun him around, lashing him like a crate across the deck, holding him in place there only by the tail-and-tentacle grip along the length of the craft. Rokey could make out the pilot towering over him on his right. He was impressed by the size and strength of the Bodoites, and he had to focus on the misty stars overhead to avoid getting seasick. On his dark left, the navigator was only a pair of eyegleams in the night. They pushed off from the dock as smoothly as if dancing. Dense jungle patterns emerged in pale light relief against the misty night sky. Jagged leaf-shapes leaned at chaotic angles over the craft on either hand as they steered silently into a narrow channel, sailing toward the lesser moon. Ragged jungle noises sounded from all sides, giving depth to the darkness.

The craft sailed on smoothly, powered by the pilot's muscular hind limbs, guided through the silver and black night by natural senses far more finely tuned than Rokey's own. Rokey felt remote and isolated, cushioned and cocooned, yet suspended precariously above dangerous depths. The night was marked out by slow ripples on the raft hull sounding like gentle bell notes. He thought of milk again, with foam like bubbles of mist across the star-studded darkness. . . .

Rokey shook himself awake. The jungle shapes against the night had given way to flats of towering reeds, tall plants with a trillion tiny points of light, static electricity sparking from the bending and twisting of crystalline stalks. The mist crawled with randomly glowing shapes and wisps of phantom light. Rokey tried not to see things in the shadows, but he could see a lot now, things in the night, steady crashes of miniature lightning rattling through sharp-bladed grasses. A roar in the darkness cut through, a guttural splitting of air and eardrum that rumbled on and on, reptilian annoyance clear in every resonance. The Bodoites sailed on without a ripple of response. Rokey stifled his own desire to hide under the boat, raising his head slightly to peer at the dark. On the shore, a shadow-shape as big as a building skulked enormously through the sparking reeds, outlined in static lightning. Eyes as big as teapots gleamed red in a black skull scaled and ridged with bone.

The Bodoites landed him at a sandy strip of beach skirting a rough pyramid of natural stone that rose out of the whispering marsh high up into the clear night sky. He was set out on the beach with the same simple gesture—the pilot scooped him up and thrust him onto the sand. He nearly fell over, more from astonishment than balance. They pushed off, sailing away silently.

The narrow strip of beach was bright, as though the sand were of diamond. The pyramid was black rock and shone in the dark. There was an erratic sparking of static at the top, more lightning. Rokey felt this was a most likely spot for a "scientist/shaman." He changed some vital settings on his skinsuit controls, and began to climb.

Bolinop was waiting for him when he had finally pulled himself up to the broad platform at the top. The aged Bodoite was over four meters tall, and seven or eight from nose to tail, although Rokey saw this bulk only as a

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mass of living darkness crouched before him in the night. There was a structure of woven bone behind Bolinop, a gleaming semi-spiral more immediately visible than the being before it. Bolinop did not move, or respond to Rokey.

The old man might be asleep. Rokey debated whether or not to wake him. It was just midnight, but he did not know whether that was early or late for the Bodoite. He stepped carefully across the stone platform toward the alien's dark bulk.

Bolinop, however, was not asleep. His headlight eyes flashed open as Rokey approached. Bolinop put out a long, ropy love-tentacle to touch the antenna of Rokey's skinsuit. "Good evening, Lord Rokhmyr." The Bodoite's voice in Rokey's suit radio was slow and thick but precisely spoken.

Rokey tried to remember the gist of Dr. Bailey's long-winded explanation for native communication, but it really boiled down to the fact that they could do it. Bolinop even used the accent and lilt of the Swinbrok family and ranch hands.

"It was good of you to travel so far to see me," Bolinop went on. "I could not come to you. I am too large and old now to climb down from my altar." There was a strange detachment to the way he declared what amounted to a death sentence. This pyramid towered high above the surrounding swamp, removed from all sources of water or food.

Rokey did not have time to understand. "It was important that I come here to talk with you," he said. He did not know why, yet. He hoped to find out, and decided, abruptly, to play a hunch. "If this time of trouble has come because the People wish that the Swinbrok would return to the stars, then it will fall upon me to tell the Swinbrok to go."

"Would you do this to us?" the aged scientist /shaman sounded anxious, although his dark bulk sat unmoved in the dark. "You would take away our star?" he asked.

"Only if it is the will of your people," Rokey said. "This is your land, your world."

Rokey was locked into the smell-deprived protection of the skinsuit, and the isolation made the drama, lit by lightning, of unreal proportions. Would "the Swinbrok" humbly accept rejection from the natives of Bodo if Rokey had to report that this had finally happened?

"The Swinbrok comes to us as a gift of heaven." Bolinop interrupted Rokey's thoughts. "It is the divine grace by which we live in this strange new land."

"Strange new land?" Rokey echoed. "I don't understand."

"There were not many of the People left when the Swinbrok threw his star temple down into our swamps. The ice walls had taken all our lands, and driven us into this place where we had never been able to live before the ice. Many thousands died in the journey here. The coming of the Swinbrok was the sign we had asked from the heavens."

"This continent is not your homeland?"

"No. The People are from the other side of the world, from a land that was broad and fair, rich in trees of great size and beauty, not like the treacherous swamps here, but the stars of that place had grown angry with us, and they sent the ice to cast us out. We ran away from the walls of ice until we came to this place, where only a single star that we recognized could still be seen hanging low between the trees. I have chosen this spot because I can see that star from here."

"That's a long journey. A great and wonderful thing for your People to have done."

"Yes. These new stars here favored us, because we had traveled so long, through such dangers, to come here. Perhaps these new stars had warred with the stars above our homes, and won us as their prize. Then, one star fell down from the sky to join us. This was the Swinbrok, who came to save us from the walkers and the eaters who feed in this place.

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The Swinbrok was injured in his fall, and we tended him, made him strong again. In return, he killed the eaters that would have eaten us. Instead we ate them, and we grew strong. We did not have to eat our children to stay alive. So the People became many and filled this land. Now, it is our homeland and we have named the stars to make them ours. The walkers and the eaters are fed to those stars. Now we eat chub birds and squanta, and we have many children."

"Could you have fought the dinosaurs—I mean, the walkers and the eaters, without the Swinbrok?" Rokey was bothered that the laws of civilization hung on such legal details, but the difference between interference and assistance was written in very fine print.

"No. Our People failed in every attempt. They are strong, enormous monsters, and we have no weapons that can hurt them. Our numbers were fewer with each night of stars. The ice walls would have eaten us if we had remained in the homeland. The beasts of this new land were eating us until the Swinbrok came with starfire. Only a god-being from the stars can kill a walker or an eater. Walkers crushed us beneath their feet, and eaters ate us, and sought our eggs, until only a hundred dozen of a dozen were left of the multitudes of the People. Too many of these survivors were men, men without women, who fought to take the eggs of others. The Swinbrok came, and now our eggs and our women are safe."

Rokey sat quietly, trying to absorb the enormity of this simply told story. An entire race, a unique evolution, poised on the brink of extinction between glacial ice and tropical carnivores. "A hundred dozen of a dozen" left out of an entire race, a People. They had been pulled back from that brink by the pure chance of a starship crashing in their midst. They had saved the first Swinbrok, and he and his family had saved their race, and they had grown rich and powerful in their own right as a result. The "stars" bought the eggs of those dangerous dinosaur carnivores, and the only payment the Bodoites asked for was music.

A magical balance, a bargain struck between strangers. A precarious balance that was about to tumble and fall unless Rokey could find the tiny lever that would restore their personal mythology of the universe. Such chaotic results of interference had made the government of civilization create laws forbidding contact with races at the level of culture of these Bodoites. But failure to interfere would have meant the end of the Bodoites entirely. Only dinosaurs would have been left to rule Bodo, the walkers and the eaters.

"But none of this tells me why you, Lord Rokhmyr, have come here, so far from your own home and the greatness of your own house."

Lord Rokhmyr had been far from his home and the greatness of his own great house, which was considerable indeed, for a long time, but this was one of those few moments when he did not mind. "There is trouble among your People, trouble between them and the Swinbrok," he radioed to Bolinop. "I have been asked to find what will end this trouble and bring peace and harmony back to the People and the Swinbrok."

"That's a tall order. I myself am deeply puzzled by it."

"Is this new trouble?"

"If I were able to know this, I could make this desired peace myself, Lord Rokhmyr. I am made helpless by the knowledge of my ignorance. I know this thing without knowing it, and this knowledge of what I do not know is a terrible burden."

Rokey felt he had just made an incredible breakthrough. Once he had figured out what the hell he had broken through to, he might have a chance of figuring out what was driving the Bodoites to riot and might, just possibly might help him to find Ray. "The Swinbrok believes that he is to blame for the changes in your people," he said.

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There was a long, lightning-struck moment while Bolinop thought about this. "This is a thing of mysterious proportion," he said finally. That made sense, but only in a nonsensical way. Rokey waited. "To place it in time, to place the beginnings in time, one must go back four seasons and more." Bolinop spoke slowly, as though he were thinking out loud, calculating. "Before then, the time of the egg harvest was solemn, even profound. The women danced in the amphitheater for the young men, and the children listened as though to a story of moon-dark."

"This has changed?" Rokey asked.

"The women hide, and the children behave unspeakably. The young men who are still building their altars become insane, and attack one another and the nestlings. It is very strange."

"And this all began four seasons ago?"

"I was still able to listen to the divine yumm-yumm in the amphitheater five seasons ago, but that was the last time. Since then, I have been here, closer to heaven. I thought, at first, that I was only envious of those free to dance in the market, but perhaps I do not imagine the madness."

"How does the madness show itself to you?"

"The young men believe they are on a mission from God, and are no longer subject to the laws of the People. They steal the magic tools of the Swinbrok, and attack the women."

"And they do these things instead of collecting the eggs of the walkers and the eaters?"

"If there is no change in this change of our ways, the eaters will rise again in numbers."

Rokey had a little trouble referring to the broadcast to the Bodoites as "the divine yumm-yumm," but that was the jargon on Bodo. "The Swinbrok believes that the broadcast of the divine yumm-yumm is the source of the trouble. Do you think this, too?"

"It is in the marketplace that the madness begins," Bolinop replied. "I would not care to believe that the Swinbrok would broadcast madness. That is not the way of the Swinbrok."

"Even the Swinbrok can make mistakes."

"And this is your purpose? To find error in the ways of the Swinbrok?"

Rokey hesitated. Bolinop had hit the matter square on target, but Rokey was not comfortable with challenging someone else's divine nature, imagined or otherwise. "It is my job to fight madness. The Swinbrok cares about the People, and it is important that the People are always free to say the truth to him."

"I cannot answer this, because I have been removed from the marketplace now for four seasons, and have not felt the yumm-yumm. I cannot tell you if it inspires this madness."

Rokey was surprised. Neither Swinbrok nor his well-informed wife had known Bolinop had gone into such isolation. Data on the People was sketchier than they wanted to admit.

"I can have them broadcast the yumm-yumm here, to you, so that you can measure its value, its flavor."

Bolinop's voice in his suit receiver was hushed with awe. "You have this power?"

Rokey clicked on his transmitter and changed settings. "Swinbrok? You listening?"

"Right here, Rokey," came back promptly in his ear. It was Daniel. "Is there a problem?"

"Maybe not. Can you arrange to have a narrowcast beamed here, to Bolinop's temple? He hasn't been to the marketplace in four seasons, he says. I want his opinion on the stuff you're broadcasting."

"Certainly, sir. It will only take a few moments to triangulate."

"Use my suit signal as a trace. I'm standing close enough to him."

"Anything specific you would select?"

"Whatever's on in the market right now." Rokey thought Daniel sounded rather cool. Rokey was certain now that

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Daniel was the problem. He wondered if Daniel suspected himself as well.

Rokey's suit picked up only the audio. The opening credit music was crisp and spare, uninspired. Rokey recognized the movie theme at once, and shrugged. B-grade stuff. A reasonable choice, not one he would have broadcast, but reasonable.

Rokey expected Bolinop to say something, but the huge alien's response to the broadcast was physical, and obvious even in the dark night. The massive shape of tendrils and tail, arms and arms and arms, seemed to swell up against the sky above Rokey, and sizzles of miniature lightning bolts danced around the knobs on the huge head, glowing in the teacup eyes. The dark bulk fell upon Rokey in slow motion, a mountain melting toward him. Rokey's reflex to pull back and run was caught up in a net of wiry tendrils clutching him all around. He fought against panic, against the urge to struggle in the tendril's grasp, pressed in by darkness. "Bolinop??" he radioed frantically. "Bolinop!!"

"Please!" rushed in over the speaker, "Please!" It was Bolinop, but the signal quavered, weak and horrified. "Please! Make it stop!"

Rokey hastily radioed to the Ranch. The movie stopped abruptly, in midsentence.

Bolinop collapsed, sagging away from Rokey, releasing him.

Rokey staggered backwards, catching himself at the edge of the platform. He was breathless as though he had been running, and astonished at how thoroughly terrified he had been.

The old Bodoite huddled away in the dark, crouching down into the emotional shelter of the spiral altar that was woven of the bones of his blessed ancestors. Purple lightning still streaked occasionally across his forehead in tiny splinters and thorns of light, but his huge eyes were squeezed shut, and he swayed heavily from side to side.

"Rokey?" That was Daniel on the radio, nervous, whispering. "Sir? Was that all right?"

Rokey swallowed down a few choice Wozurn curses, regretting that the man would not understand the nuance. He made himself take a deep breath and another before replying. "Shut up. We're on to something."

Rokey's curiosity over Bolinop's reaction to the signals overwhelmed his residual terror. "Has the yumm-yumm ever done this to you before?"

"Nothing has ever been like that before! That was not the yumm-yumm sent by the divine! That was the essence of darkness, that was the flavor of the marrow in the Devil's bones!"

"Bolinop, you have to help now. We've found the problem. That's half the solution."

"Yes. Yes, this is urgent. I cannot abandon my purpose before a danger as great as this. The People will become monsters if this is not stopped."

"It was as bad as that?"

"I have no words that will fit into your language to tell you of how bad! It will change us."

"Then help me with some more experiments, Bolinop. Can you face another broadcast?"

The dark bulk shuddered. Rokey felt it, but Bolinop answered gravely. "I will face it. I have my own honor to defend now. I have lain here in the comfort of my temple and let this happen to my People. I will face anything to undo that."

"What's your favorite movie?" Rokey asked. "From before the last season you were in the marketplace?"

"Chilam Balam," Bolinop answered at once. "No yumm-yumm has bathed my soul in light more sweetly than this." He sounded wistful, as though the question had raised memories.

The Chilam Balam was an ancient fairy tale from the Swinbrok's homeworld of Terra. Rokey knew the movie version fairly well. It was a classic that had stood the test of a thousand years of

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interstellar audiences. It was appropriate to the Bodoites' enforced exile in the jungle swamps of their world, since it was myth from a jungle culture.

Rokey radioed back to Daniel, and told him to narrowcast just the first sixty seconds.

Bolinop reared and stiffened as though he had been shot, and then sagged back limply when it stopped. "That, that is not. That was not." His radio voice was a whisper. "No." Bolinop interrupted himself. "I did feel some of what I remembered, the magical song of the story was there, but buried, as though seen through swamp bile, as though evil had woven threads through every line. It is difficult to find words. The stench of it!"

Rokey had seen the movie on his own suit screen. That was the Chilam Balam as he remembered it, and a clean edition.

"We'll try again, Bolinop. You catch your breath while I set this up, and I don't think this next one will be so bad."

Rokey called up the Ranch. "Channel my signal into the line that you've got to my ship."

"Of course, sir. It won't take a minute."

Rokey realized that Daniel was in charge of communications, and that was the reason he had done the programming for the Bodoites' "divine yumm-yumm" broadcast. Another clue clicked into place.

Once in radio communion with his own starship, Rokey sent the command signals to the remote unit he had set up to listen for Ray. A few moments of fancy back talk to the shipboard computers gave him access to his own private movie file, a file larger than those owned by some planetary libraries. A few more minutes of crosstalk with his private broadcast system got his copy of the Chilam Balam, with a specifically coded change, beamed directly to Bolinop.

Five long minutes went by, and Rokey had some time to worry. When Bolinop made no response at all, Rokey signaled the ship to stop the broadcast.

"Bolinop?" he called.

"I had thought all such magic was gone out of the world," Bolinop said wonderingly. "Or gone out of me. I sat here, bathing in the thin songs of the sky and listening to the lightning, and I let fade the flavor of the yumm-yumm that the Swinbrok brings us from the stars. How could I have forgotten a magic that is so real?"

"So, that one didn't hurt?" Rokey said. "But that was the same movie, Bolinop."

Bolinop paused, tasting the two memories, and said, "Yes. I do not know how it is possible, but they are the same and they are not."

"And in that lies all the difference, Bolinop, and maybe our solution."

"But what makes them so different if they are the same?" Bolinop said. "How can the one be divine, and the other so unclean?"

"You have to tell me," Rokey said.

"It was the song of the Perfect Tree in both. But in the first, a hungry wind moved through the leaves, like an evil mist concealing it. It sounded as it should, but the flavors in it, ugly, as ugly as Devil's spit, and yet. . . ." The alien paused, for so long that Rokey almost worried. "Do you know the flavor of fire?" he asked abruptly.

Rokey was surprised by the question. "I know what smoke smells like, all kinds of smoke."

"No, the flavor of fire is not the smell of smoke. These two are not even of the same quality. This version of the Sacred Tree story was as different as the flavor of fire and the flavor of the stars overhead. I had not known a thing could taste like that, change like that." His shudder made the mountaintop tremble beneath them. "What could cause such a thing?"

Rokey was beginning to think he knew. "Daniel?" he snapped into the comlink. "How long ago did you get your new satsystem?"

"Twelve years ago, sir, solar."

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"And how many market seasons is that?"

"Just about four, sir, a little more. Why?"

Rokey knew that would be the answer because he had predicted it before calling. He was certain now. "Come and get me," he growled into the microphone. "I know what to do now."

"Rokey, sir—Bolinop doesn't want anyone . . . "

"Bolinop's exile is over as of now." Rokey cut him off sharply. "You can't afford to go on without his advice—and he's wasting away up here. I want something done about that."

"Rokey, sir!"

"Put it on my bill!" Rokey snarled.

"I can be out to you in about twenty minutes, sir."

"Do it."

Rokey decided to play one more hunch, and picked up Bolinop's antenna. "I need your help. My partner disappeared just after we arrived. I'm pretty sure his suit can keep him alive out here, but I have to find him soon."

"This is an important thing to you," Bolinop said slowly. "I sense this in the color of your words. Describe your partner to me, tell me of the place of his loss, and I will send the young men of my village in search of him."

When Rokey described the gold skinsuit that Ray wore, Bolinop interrupted and began to ask many detailed questions. What flavors of light would the goldtone reflect? How powerful was the signal being broadcast to his suit receivers, how narrowly was its beam focused? Rokey was surprised by the precision of the questions, but he was taken completely by surprise when Bolinop calmly told him that this was the explanation of what had happened to Ray.

"Your partner has been mistaken for a god-being of golden substance, for a newly-fallen star. One of the single young men has put him into an altar somewhere."

Rokey asked if that narrowed down the search or made it worse.

"There are many young ones with altars in the wild. The madness has affected them all but not all have territory on that side of the Swinbrok Temple. I know of one in particular who would seize a god-being in a golden skin if he found one."

Rokey's innards did a flip-jump of chemical reaction to the return of hope. "How difficult will it be to find this one?"

"It can be done, even with eyes that do not see the taste of fire."

Rokey called up the connection to his ship, and tied into his movie collection. "While we're waiting for my ride, Bolinop, would you care to watch the Chilam Balam, the clean version?"

"Thank you, lord Rokhmyr. Do you believe then that you can stop the madness?"

Rokey was very tired, and worry chewed at him relentlessly, the ache inside of his fear for Ray, but he tried to sound positive. "I can stop the madness."

Six

Folobolos sat in the entrance to his temple, and opened himself to the divine yumm-yumm which the god-being drew down steadily from heaven, wild patterns of angels dancing over shining pathways, trees that blossomed in darkness, soaring arrays and flavors made visible in his brain, sounds and colors seen behind his eyes. There was nothing here that smelled, or sounded, or buzzed like Bodo. Here was only the alien spicy otherness of star songs.

This tangible reality of the stars was the guide and focus of his existence now. Another star had fallen onto Bodo, another god-being had been found, but this time Folobolos held the golden being on his own, private altar. As final proof of the rightness of what he had done, the wild imagery of the divine yumm-yumm regularly became the simple message, "Relax, son, I will find you. I haven't given up."

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Seven

Ray Harris struggled to extract himself from the peculiar structure into which he had been woven. He did not get far. The numbness in his hands and feet was alarming. He could not move and could not feel enough to know why. At least, he did know that Rokey was looking for him. Ray was sure of that because Rokey kept interrupting the music broadcast to say he was coming for him. Rokey also kept changing the music tapes. Ray was sure he would have gone completely wild if he had had to listen to that same tape one more time. That same tape that had been his favorite just hours before. Ray struggled to move his shoulders or his hips, tried to separate some part of himself from this bone straitjacket, but he was painfully locked in. He could lift his head, but only enough to see the monster who stood guard over him—a bulbous mass of tentacles and ropy arms, with eyes too big and too bright, with some kind of sizzling glow to the knobs atop its lumpy head. It stood poised against a misty night sky in an alien gesture that Ray perceived, somehow, as reverent. Ray lowered his head, stopped his struggles, and lay back to listen to the music. Rokey was running through his file of favorites. Ray prayed he would only have to hear them all once.

"I've got it figured out, Ray." Rokey's voice broke into the music.

Ray woke up enough to wonder why Rokey sounded so tired. The message repeated, and Ray was completely, painfully awake.

"We're in a flitter on our way, maybe half an hour away. Stay alive."

"Sure. Easy." Ray could not reach the receiver toggle. He could not reach much of himself at all. His skinsuit assured him he was alive, but he was tightly clamped inside it. The reverent dragon still prayed against a flashing sky. Ray put his head back and tried to focus on the music.

Eight

Folobolos saw the glowing orange lights floating toward him in the mist above the swamp, and his many pumps swished inside him, stirring his depths, filling his lungs with excitement. He reared up, stretching his love tentacles out to the approaching glow.

The divine yumm-yumm evaporated and was gone. Instead he was struck by the cold gray flavors and texture of the Swinbrok's holy signal. These touched his raging brain with a cool, familiar taste. Folobolos sat back on his tail and drew in. The lights floated up closer, resolving out of the mist, and turned into the private flying altar of the Swinbrok.

"Folobolos? Is that you?" the Swinbrok said.

The brush of the divine presence was ten thousand soothing fingertips on Folobolos' fevered brow. His moment had come. He put his longest, finest love tentacle out to the flying altar's antenna. "Swinbrok, it is I, Folobolos."

"Have you been enjoying the music, Folobolos?"

Folobolos could not fathom why the Swinbrok had come here, through the mist and swamp, to ask him *this* face to face. Was this some terrible test he had not foreseen? Could he lose everything on a wrong answer? He fell back on the answer that was often safest to questions: "Thank you."

"You know there is always a price for the music, do you not?" The Swinbrok spoke to him with a perfume in Folobolos' brain that tasted of infinitely small black dots gathered on an infinite, white plain.

"Yes." Folobolos knew. He had not forgotten, but he trembled.

"What does Folobolos have to give in return for the music?"

Folobolos knew that his immortal soul hung now in the balance. He had bridged the dimensions. He had brought the Swinbrok Himself out of the Holy of Holies, brought His sacred presence to the altar which Folobolos alone had wrenched up from the swamps. The People would have to see now that

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Folobolos *must* be king! What, *what* in the name of heaven, could he trade to heaven for this moment?

"I have the fire of heaven, Swinbrok," Folobolos beamed to the antenna, answering without knowing the source of the answer. He knew. His soul knew what heaven required in return for kingship. "I have the body of the fallen star. I can give you a god-being."

Carbon-black fireworks, droplets of mist, colorless harmonics washed over Folobolos as the Swinbrok spoke to him. "This is a fine trade from Folobolos. This is so fine a trade that Folobolos will be welcome all season at the amphitheater as the personal guest of the Swinbrok."

Folobolos knew his strength when he felt it, knew when his strike would hit true. "May I bring a guest, Swinbrok?" he asked cagily.

Swinbrok's reply, "Yes, you may bring a guest" was so thrilling that Folobolos trembled all the while that he tore the altar-weavings away from the golden being. He felt his skin change colors, cold to warm, to hot, to chillingly dark. He clutched the god's golden flesh to his own, touching it for a final communion, and then lifted the glowing form up to the Swinbrok's altar. The Swinbrok further honored him by touching His flying altar to the edge of Folobolos' temple. Sparks flew all around in purple flashes of divine eminence. One of Swinbrok's servants, thick, and bulky and black in the electric light, sprang out of the altar and took the limp form of the golden god into its charcoal arms.

The Swinbrok showered Folobolos with a symphony of cloud-colored river swirls glowing with dark light, midnight colors flowing through Folobolos with a haunting and familiar ache. Folobolos was swept away, triumphant. Rhopalura would be his guest at a concert given just for him. He could taste the kingship in his teeth, could feel Rhopalura writhing in his claws.

When Folobolos awoke from this contemplation, the lightning-bright sky was silent, and only the rumble of eaters cut through the misty dark.

Nine

"Yes," Rokey repeated calmly to Sam Swinbrok. "I blew up your broadcast satellites. In fact, I blew up your *entire* satsystem." Rokey tried not to let it show in his voice how satisfying it had been to do that. "I shot down everything but the house phones."

The fragile old man was translucent with rage, sweating with confusion. "Those satellite broadcasters were brand-damned-new, and I paid a *skinful* more for them than you're worth!" Swinbrok glared at Rokey. "You were supposed to help us, not demolish us!"

"Your insurance can be made to cover," Rokey said wearily. He felt gray and utterly drained. "You can pick up the replacements you need in any junkyard. You have to have cheap, the cheapest money can buy."

"Damn you!" The ancient Swinbrok was leaning on his son's arm as though supported by his own shadow. "And you call yourself an expert!"

"You didn't need a movie expert," Rokey said, summoning lost patience. "But sometimes it takes an expert to see the obvious. Your problem was your own ignorance of the people who work for you. I simply solved your little problem for you all at once. I had to get my partner back before blood poisoning set in. Our hospital unit can put his hands and feet back together, but it was too damn close. I had to think of him first."

"Of course, you did," Daniel said softly, firmly. "Satellites are only property."

"You had to replace them anyway," Rokey went on, more loudly. "Don't ever again use *anything* that broadcasts in *color*. Color signals are perceived as pure psychosis by the Bodoites, and your new system of satellites all had *automated* color controls. . . . " Rokey was almost shouting now. He couldn't help it. "I couldn't change the video to simple black-and-white, so I blew them all up!" ■

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THE REFERENCE LIBRARY Tom Easton

Factoring Humanity, Robert J. Sawyer, TOR (ISBN: 0-312-864-582).

Earth Made of Glass, John Barnes, TOR, $25.95, 416 pp. (ISBN: 0-312-85851-5).

Helm, Steven Gould, TOR, $24.95, 383 pp. (ISBN: 0-312-86460-4).

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Ports of Call, Jack Vance, TOR, $24.95, 300 pp. (ISBN: 0-312-85801-9).

Forrest J. Ackerman's World of Science Fiction, Forrest J. Ackerman, General Publishing Group (2701 Ocean Park Blvd., Suite 140, Santa Monica, CA 90405), $30, 240 pp. (ISBN: 1-57544-069-5).

The Roving Mind, Isaac Asimov, Prometheus Books (59 John Glenn Drive, Amherst, NY 14228-2197; 1-800-421-0351) , $18.95, 350 + xxx pp. (ISBN: 1-57392-181-5).

The basic question Robert J. Sawyer asks in his fascinating tenth novel, **Factoring Humanity**, may seem familiar to anyone who works with computers, but it could easily have been asked long, long before such gadgets were ever dreamed of. Indeed, it must have been.

That question deals with the slipperiness of memory. We forget. Sometimes we repress. Sometimes we recover memories that find no confirmation in the recollections of others and no external evidence of a more material kind and that threaten great disruption. If this vague description of the situation rings a bell, that is because in the last few years the news media have carried a number of reports of people who have recovered memories of childhood sexual abuse by parents, ministers, teachers, and others. The accused abusers vigorously deny the charges and there is no outside confirmation, but their lives and careers may be ruined. In a few cases, the accusers have later recanted; the "memories" of abuse were created in them by therapists who imposed their own expectations on their patients.

This is where Sawyer begins. Psychologist Heather Davis and computer scientist Kyle Graves separated after the suicide of one daughter. Now their second daughter accuses Kyle of molesting her as a child. Kyle vigorously denies this. Both Kyle and Heather are aware that memories can be repressed. Heather visits their daughter's therapist incognito and is told that she too was abused by her father, even though she knows that was not possible.

Did the therapist create the memory of abuse in their daughter? Or is the memory real? How to settle the question? If only there were some external backup of human memory that could be consulted!

In the nature of fiction, the various elements of a story must be related. Kyle's work centers on artificial intelligence (he even has a rather personable program called Cheetah) and quantum computing, with an eye to factoring large numbers (which would destroy

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any security system based on encryption). Heather is a Jungian who wants to decipher the 2,843 inscrutable messages from Alpha Centauri. She's the one who realizes that the messages can best be represented as the faces of an unfolded hypercube. She constructs the faces, hooks them together, and crawls inside her construction to discover . . .

Jungians believe in archetypes as reflections of a shared, species-wide subconscious or "overmind." Not surprisingly, what Heather finds has something to do with this and with memory backups and with a great deal more besides. Sawyer has constructed a fascinating fantasy loaded with quite charming implications, hardly least among which is the utter destruction of privacy.

I loved it. May you also.

In *A Million Open Doors*, John Barnes said that the human species will proliferate in the galaxy, spawning the civilization of a Thousand Cultures derived from ethnicity or religion or myth. When instant travel via matter transmitter or "springer" is invented, all these cultures will be put in touch with each other, with inevitable shock, disruption, and change. The Council of Humanity will send out diplomats to aid the transition, with a secret agenda of unifying humanity so that when it meets the aliens whose artifacts keep turning up, it will present a single, solid front.

Among those diplomats are Giraut and Margaret, whom we met in *Doors*. Now, in **Earth Made of Glass**, they have been posted to Briand, a hell-world where people cling to mountain plateaus above toxic lowlands. This planet was settled by two groups, one dedicated to recreating the culture of the ancient Maya according to academic reconstructions, the other dedicated to restoring the glory of ancient Tamil literature. Unfortunately, volcanic eruptions damaged the Maya colony, Kintulum, and forced the survivors to establish a refugee enclave in the Tamil city of New Tanjavur while Yaxkintulum (New Kintulum) was constructed. The enclave has remained as Mayatown; its residents are persecuted by the Tamil majority; each group hates and fears the other, just as here and now do similar groups in Northern Ireland, Palestine, India, Bosnia, etc. They don't talk to each other, and the Maya don't talk to outsiders such as Council diplomats, either. Yet Giraut and Margaret are supposed somehow to bring them into the fold.

Giraut and Margaret are married, a couple with a history of shared life and joy and work. Yet not long after their arrival, Margaret grows prickly. The reader, more astute than Giraut, suspects pretty quickly what is going on, but Barnes plays coy as Giraut meets with Tamil poets, is invited to visit Yaxkintulum and meet the Maya prophet who may finally bring Briand home again, and remains oblivious to every hint.

Barnes pays close attention to how people can be astonishingly compulsive about what are really no more than stories. This is especially obvious with the Maya, whose culture is based on a very small handful of actual Mayan inscriptions and codices but whose very streets are paved with computer-generated myths, carefully crafted to be consistent with the real documents and exercising just as firm a grip on the Maya mind.

The Tamil are harking back to a time when the great Cankam poetry, which critics have enshrined as on a par with Shakespeare, was written. They want to create conditions that will permit more such poetry to be written. Alas, the best they can do is to imitate the past and argue obsessively over how close they are coming.

Giraut is a poet too, a songwriter and singer in his youth, but he grew up (see *Doors*). He can still do it, but he doesn't much. And when he does, he does not try to imitate the way he used to do it. He sings of current concerns in more mature ways.

And both the Tamil and the Maya are

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on the verge of doing something similar when . . . well. Think of Northern Ireland and Bosnia and Palestine, where thousands of people have died for their stories. "On the verge" can be rephrased as "on the brink."

Doors wasn't bad at all. *Earth Made of Glass* is better, stronger and more convincing. I recommend it heartily.

John Barnes and Steven Gould both live in the southwest. Different states, to be sure, but they must meet at cons from time to time and, like many writers, share nifty notions. If so, then perhaps Barnes's *One for the Morning Glory* (reviewed here in July 1996) and Gould's **Helm** share roots. Both quote the song Barnes cited in his title, and both concern medievaloid kingdoms threatened by rapacious invaders and reclaimed by heroic princes.

There are profound differences, however. Where Barnes's book was a slight, comic fantasy, Gould's is SF that should appeal to the most hardened of *Analog* readers. Its roots lie in the collapse of Earth. A few desperate survivors cling to a Moonbase and struggle to find a way for humanity to survive. Probes have begun the terraforming of a world of Epsilon Eridani. A ship can be sent with a library and four thousand cold-sleepers and—since much basic equipment cannot be spared—a code of cleanliness, nutrition, and literacy to ensure a sane if low-tech colony. To ensure the code, the ship will also carry "imprinters," devices that can transfer knowledge directly into one's brain but can also be used to change beliefs and loyalties willy-nilly (the use of such devices indeed helped spark the latest wars on Earth).

And so, centuries later, here's the kingdom of Laal, centered on a fertile mountain valley. Here's the prince, youngest son Leland de Laal, climbing the Needle, a spire of rock atop which sits the Glass Helm, relic of the past. The Helm looks like a spacesuit helmet, and all are forbidden to don it, but Leland puts it on anyway. When he comes to . . . well, it takes awhile, but in due time things he never learned start coming to mind, notably including martial arts and quotes from books in no library of his world. Clearly the Helm is one of those imprinters.

Meanwhile, politics is brewing. The overlord to whom Leland's father owes fealty comes a-visiting. A weak shadow of his late father, he resents Laal's prosperity and freedom. His daughter hits it off with Leland. And then the overlord proceeds onward to Cotswold, a neighboring kingdom that has long threatened Laal's borders, returns with his daughter engaged to a wicked prince, loudly announces a treaty by which Cotswold swears to respect Laal's borders, and summons Laal's forces to the annual war against the barbarians.

Gould does not conceal the nature of the scheming going on. The hints of plots and secret agendas and traitors are numerous and plain, and even Leland's father is suspicious enough to take certain precautions, including putting Laal's expeditionary forces under Leland's command. Leland's just a kid, but by his own virtues and with the aid of the Helm's knowledge, he wins over his troops. He then proves himself a hero just in time to respond to the invasion of Laal.

Does he get the girl, too? Well, you know how these things go, don't you? Suffice it to say that this is one you'll enjoy.

The third volume in Mike Resnick's *Widowmaker* series, **The Widowmaker Unleashed**, is now available, and it makes a very fitting end to the trilogy. If you recall, the title character, born Jefferson Nighthawk, was once the greatest of galactic bounty-hunters. Alas, he came down with a dreadful disease, eplasia, that rotted the skin from his body so that his knuckles and cheekbones (etc.) showed through and gave grown men and small children night-

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mares. In a last ditch effort to survive, he had himself frozen to await a cure. When his money ran out too early, his lawyers had him cloned (illegally) and sent him out to raise some cash. The clone succeeded, but he also got himself killed.

And the money he raised soon ran out. Enter clone #2 for volume 2, *The Widowmaker Reborn*. He was more successful—he raised enough to see the original through to the cure, and he survived long enough to vanish.

And now, at last, the Widowmaker himself emerges from the clinic, 62 years old with 112 years of ice-time behind him. He's weak and he's tired. All he wants to do is go off and raise flowers. But he's also determined to be the Widowmaker, as fit as he would have been without the eplasia, as fast with his guns, and twice as canny as his clones.

It's just as well, for his clones made enemies who are quite prepared to come gunning for him. His rep doesn't help either, for there are plenty of young toughs who would love nothing more than to be known as the one who finally beat the Widowmaker. So what's a poor old eplasia survivor to do when all he really wants is to be left alone to grow old with his new girlfriend?

Well, the Widowmaker is canny, as I said. He finds a way, and if it costs him the companionship of Ito Kemosabe—er, that should be *Kinoshita*—that is the price he must pay for peace.

The premise of Michael Kanaly's **Virus Clans** is very interesting: Viruses communicate by passing proteins back and forth and have as an aim the modification (via mutation and natural selection) of their hosts to give the viruses the capacity for higher thought and access to eons of memories of past days when viruses—with their hosts—ranged the spaceways. This much is clear very early in the tale as Kanaly shows us an alien world destroyed and clouds of surviving virus drifting through space until they came to Earth when the only living things to be found were bacteria.

Meanwhile, not too far in our future, researcher Gary Bracken is at work on the development of a computer that will be able to store information in encoded protein molecules. He learns that viruses are passing proteins. Realizing that termites pass information in the form of proteins and have suitable apparatus to read that information (how else could a queen tell a larva to become a specific kind of worker and instruct it in its tasks?), he starts studying termites, makes progress, gets a glint of the virus messages, and is shut down by national security as madness—sudden visions of past lives, strange worlds, and so on—spreads through the populace. The virus clans, it seems, are on the verge of success in their grand mission, and if a couple of billion human beings must be sacrificed, well, that's just evolution in action.

Marvelous stuff. Great story. It's got all the sweep and scope and angst anyone could possibly wish. Unfortunately, if you know much science at all, it will drive you nuts. For one thing, Kanaly seems to have no idea of the amount of protein or DNA it would take to encode the amount of information he credits to a virus's internal store, nor of how limited is the internal volume of a virus. As for the volumes of information passed among termites, it seems much more the case that a termite queen emits a chemical that simply activates preprogrammed subroutines already present in the recipient's genes. And his portrait of the scientific world manages to leave out entirely the Internet; if it had not, his government cover-up of the signs of disaster would surely have been untenable. On a more trivial level, "bacteria" is a plural noun, not a singular one.

There are other gaffes as well, but these are enough. I suspect Kanaly's intellectual home is in the humanities. This would explain the problem, though it would not

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excuse it, any more than saying that Greg Benford (strictly for instance) is a physicist would excuse his (hypothetical, mind you) comment that the native language of France is Chinese or that Shakespeare wrote *The Pickwick Papers*.

Surely, any scientist who made comparable mistakes in the humanities would be lambasted by the humanities folks as "half-educated."

Scott Mackay's **Outpost** begins interestingly enough but ultimately fails to live up to its promise. The setting is a prison on a distant world. The jailers, the wolflike *uomolupo*, have been gone for ages. What remains are the robot *carceriere*, each one armed with a *pistola*, and, atop the walls, the *sentinelle* armed with *cannone*. The prisoners are kept docile by dreamphones and drugs.

But the system is breaking down. The robots are crumbling, the dreamphones and drugs no longer pacify, and some of the prisoners are awakening. Meet seventeen-year-old Felicitas, who remembers being a male murderer; she is apparently the descendant of the original prisoner. Meet Piero, Gasparo, Rosario, men who had awakened a few years earlier and have been working on an escape plan ever since. Meet Lungo Muso, a ghostlike *uomolupo* who talks to Felicitas and a few others, teaching her the ancient writing of the aliens, hinting that there is war between his kind, the Old Ones, and strange, vat-grown New Ones. Meet Maritano, who is fast becoming the leader of the unawakened and soon reveals that he is acting for those New Ones as he battles to stop the escape and claim Felicitas for himself.

What's going on? If I say too much, I'll spoil it for you, but the cover blurb reveals that Old Ones and New Ones are warring through time itself to control the human past. I'll add that the root is the *uomolupo* effort to cancel out a human imperialist fiend, and that Felicitas is the key to a successful outcome.

Unfortunately, aside from various unlikelinesses including extraneous *soldati* who are lousy shots, the action Felicitas must finally take seems so obvious as to put the novel into the "idiot plot" category (meaning the tale exists only because important characters—here, characters safely in the story's past—are idiots).

Jack Vance—born in 1916—is one of the Grand Old Men of science fiction. In his time, he created some of the field's seminal tropes, meaning that he has been much imitated. Unfortunately, though he's still writing, he seems to have joined the ranks of the Vance-imitators. His latest, **Ports of Call**, has no claim at all on seminality. What marks it instead is something that has always been present in Vance's works and has unfortunately dominated his lesser works, of which this is surely one—a distinct preciosity of names and manners and folkways.

Meet Myron Tany, who dreams of interstellar adventure and has earned a brand new degree in "Economic Fluxions" (the basics of interstellar Gaean civilization). He is a hanger-on to his rich and capricious aunt, Dame Hester Lajoie, who thinks she is beautiful and young, is actually ugly and long in the tooth, and has won a spaceship in a lawsuit. When she hears a rumor of a clinic with a lock on the Fountain of Youth, it is heigh-ho and off they go, with Myron as the captain of the ship until he dares to cross one of her pet sycophants. Shortly he is crew on a tramp freighter hopping from world to world and seeing sights galore.

And that's it. Myron nurtures dreams of revenge upon Dame Hester, but nothing happens. And nothing happens. And nothing happens. This is a running-in-place novel. There's plenty of scenery, but there's no real movement, and the reader winds up wishing she hadn't bothered.

Or is there a sequel in the works?

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There wasn't a hint on the bound galleys TOR sent me, but perhaps the original manuscript was too big and TOR chopped it in half. If so, we will soon realize that *Ports of Call* is only half a book, which would explain much.

But it won't make the reader any happier.

Forrest J. Ackerman is another SF oldtimer, but though he has done his share of writing, he has also been fan, agent, editor, actor, and above and beyond all else, collector. His "Ackermansion" museum is famous in fandom for the hundreds of thousands of SF books, magazines, and movie memorabilia it contains. If you wish a glimpse of the collection, you can visit California. Or you can spend a little less for a copy of **Forrest J. Ackerman's World of Science Fiction**.

The book is divided into five sections. The first discusses the history of the Frankenstein idea from Mary Shelley to the latest (1995) film version of the story and provides a host of illustrations from movies, books, and even comics.

Later sections focus on early "Sci-Fi" (Forry's preferred term) authors, the pulps, movies, and TV. Overall, the pictures dominate the text and give the book its great strength as a visual tour of SF's past and a survey of the changes it has undergone.

Isaac Asimov's **The Roving Mind** was first published in 1983. The publisher has decided it is worthwhile to reissue it with a foreword by Paul Kurtz, founder of the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP), and with tributes by the late Carl Sagan, Stephen Jay Gould, Arthur C. Clarke, Frederik Pohl, Martin Gardner, L. Sprague de Camp, Harlan Ellison, James Randi, and others. The foreword is new; the tributes first appeared in *The Skeptical Inquirer* (CSICOP's journal) after Asimov's 1992 death.

Like so many of Asimov's books, this one is a collection of essays—sixty-two of them—drawn from a host of magazines. Many deal with topics of very recent interest, such as cloning, SETI, technophobia, and computerization. The book's first six remain especially relevant, for they deal with the onslaught of the religious right, which has not abated one whit in the last fifteen years; the titles alone are enough to hint at their content: "The Army of the Night," "Creationism and the Schools," "The Reagan Doctrine," "The Blind Who Would Lead," "Creeping Censorship," and "Losing the Debate."

The book remains as edifying as ever, and as deserving of a place in every school library in the nation. To be sure those libraries get copies, why not buy two, one for yourself and one to donate? ■

There is a difference between doing nothing and being bored. Being bored is a judgement you make on yourself. Doing nothing is a state of being.

— Robert Paul Smith

Religion is belief in a supreme being. Science is a belief in a supreme generalization.

— Charles Fort

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BRASS TACKS

Dear Dr. Schmidt,

I agree with essentially everything you say in your editorial, "Defenders of the Faiths" in the March '98 *Analog*. However I think it would be a good idea for you to apply the criticisms you direct toward your letter-writing readers to the "science fact" articles before you publish them.

One fallacy is misinterpreting a theory. ". . . People who claim they've disproved relativity, but who soon make it painfully clear that they don't even understand what relativity *says*. . . ." Jeffrey D. Kooistra's "Paradigm Shifty Things" criticizes general relativity theory (GRT) for claiming that gravity is propagated by gravitons when no experimental evidence for them exists and he doesn't like the idea. However, GRT says nothing about gravitons. The notion that gravitons may exist comes about from physicists arguing by analogy with electromagnetism (photons), the weak interaction (vector bosons), and the strong interaction (gluons), but no successful quantized gravity theory has yet been invented. Thus the criticism usually directed at GRT is that it *doesn't* predict gravitons. But everybody (except Kooistra) may be surprised if eventually science decides they *don't* exist. (Note that GRT *does* predict gravitational radiation which is just ripples in the curvature of spacetime propagating at the speed of light. It hasn't been detected either.)

Consider the "instantaneous propagation of gravity" argument. It is not that the spacetime curvature of the sun is propagated instantaneously; it is that it has *already* been propagated. Bit by bit, as the sun was assembled from chunks of infalling matter, its gravitational field (curvature of spacetime) grew instantaneously (Newton) or with a ripple of gravitational radiation (Einstein) each time a chunk arrived. No instantaneous propagation is required to cause the planets to orbit.

Another fallacy is that one can know how something is by just thinking about it. This one goes back to Aristotle and before. Even Einstein's belief that "God does not play dice" led him to spend his later years in fruitless attempts to put determinism back into quantum mechanics. In Kooistra's article, arguments are made as to what would happen to the Earth's orbit if the sun went *poof*. Would the earth immediately fly off in a straight line or would it wait for 500 seconds and then fly off in a straight line? How can anyone know the answer? The experiment can't be done. Mass has never been observed to just cease to exist. Newton's theory demands conservation of momentum. GRT demands conservation of mass-energy. It is true that matter and antimatter can mutually annihilate each other and create electromagnetic radiation but (by GRT) the total mass-energy is conserved. All of the mass-energy of radiation is in the form of kinetic energy, but kinetic energy, like all mass-energy, curves spacetime (according to GRT). The gravitational field is unchanged an instant after the annihilation occurs. Of course it subsequently changes rapidly as the radiation rushes off at the speed of light.

In Kooistra's article, GRT was accused of crimes it didn't commit. We know that the theory is incomplete because it does not account for quantum effects, just as quantum theory doesn't account for gravitation. It is in the merger of

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these two great theories that the real opportunity for paradigm shifts exists. But just maybe . . .

I believe your "science fact" articles are a good idea. We laymen can get the mainstream science from *Scientific American.* However, a little critical thinking by the editor and the authors could go far towards improving their quality. I don't mean criticizing them based on mainstream science, but just requiring them to correctly interpret the theories they are attacking, present experimental evidence for their new paradigms, and not assume that someone can figure out the truth just by navel contemplation. You have an opportunity to educate your audience in critical thinking and how the scientific method works through example in the articles as well as in your above mentioned editorial. Think of how much better an article Kooistra could have written if, instead of just parroting the garbage in the original source, he had presented it with criticism of its weak points and pointing out where it raised valid points (if any). John Cramer knows how to do it.

JAMES C. WILCOX

But then you, the reader, must be careful to accurately read and represent what you criticize—and I don't believe you've done that here.

Stan,

Regarding your defense of *Analog*'s "science fact" articles in the March issue:

Much of what you say is true, but two major aspects go unmentioned.

First is the obvious fact that your choices are limited. Among those articles available to you, you pick that which best suits your needs. At times, I'm sure, you may not be too happy with any of them.

Second, and most overpowering, is the truly incredible delay in *Analog*'s publication. Given today's technology, there seems to me no excuse for it. How in the world can you hope to deliver "cutting-edge" science info when the article must be in hand six-to-eight months before publication? The edge has long since been cut. And scabbed over. And formed scar tissue . . .

Granted, you may never match the speed of the Internet, whereupon an interesting idea may circumnavigate the globe within hours of its conception. Nevertheless . . . it should be possible to deliver news of significant scientific developments in a more timely manner. I note that the British weekly magazine, *New Scientist*, in two recent issues, informs us of 1) a new type of electronic refrigeration, 2) a potential digital network switching system based on an analogy to the ant colony and its path choice mechanisms, 3) the discovery of the mechanism accounting for fractional electronic charge, 4) a high-powered miniature antenna of fractal design, and myriad other tidbits.

One other gripe—you say that the authors "are scientists themselves," as if that somehow sanctifies them. You might remind your readers that the label "scientists" applies to a population that is diverse indeed. The difference between a journeyman "scientist" and a Feynmann, say, is far greater than that between the typical "scientist" and the average "non-scientist." You must be able, from your own experience, to recall instances wherein a "scientist," or even a "professional scientist," was utterly wrongheaded.

WARREN RAYLE

We have never claimed to deliver "cutting-edge" science, and we probably won't soon—except, perhaps, on our new website. Print media, especially ones on limited budgets, just don't lend themselves well to that. Even the print journals in which scientists communicate with each other still take several months, typically, to publish papers; they depend on the Internet for the hot-off-the-lab-bench, relatively

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untested stuff. What we can deliver is information about things which have been around long enough to have withstood some *scrutiny, yet new enough that our readers aren't likely to have read much about them elsewhere.*

I certainly never implied that being a scientist "sanctifies" anybody—but neither can I agree that the difference between a trained but undistinguished scientist is greater than that between a run-of-the-mill scientist and a typical layman who has little or no understanding of scientific method or content.

Dear Sir:

Neither the March 1998 editorial, nor Dr. Eugene F. Mallove's July/August 1997 article on cold fusion, nor the references cited in the article, consider the possibility that *cosmic rays* may be the UFOs (Unidentified Fusing Objects) responsible for cold fusion.

The only objection ever raised to cold fusion is that it is not energetically possible, unless something else gets involved to supply the necessary energy. By a process of elimination, the "something else" must be cosmic rays. What else?

It is hypothesized that something catalyzes the fusion reaction, but ordinary chemical catalysis is not enough. Cosmic radiation, present in minimal amounts, may be the essential catalyst which kicks the fusing particles together (so to speak) by imparting the necessary energy to them through high-energy collisions.

The good side of this is that it is a possible mechanism for cold fusion. The bad side is that it is not a practical mechanism for useful energy production.

Just as unidentified flying objects turn out to be something ordinary when identified, unidentified fusing objects will probably turn out to be something ordinary like cosmic rays. The only way to test this is to find out if cold fusion occurs in the absence of cosmic rays.

If the incidence of cold fusion decreases inside of thick-walled lead chambers, or deep underground, that would corroborate cosmic rays as the catalyzing culprits. If they cause the effect, it will disappear as sufficient shielding is set up to keep them out.

The old saw, "If it seems too good to be true, it probably is," applies here as well as anywhere else. It's not a matter of faith. It's just a matter of common sense.

KENNETH J. EPSTEIN

Dear Stan,

Reader Harvey Bellamy's letter (March 1998) correctly cites cultural differences to account for behavioral differences between social groups, but unfortunately he also appeals to race as another explanation. In this he reproduces a popular belief of our culture, but one that confuses a social category with a biological one. Certainly genetics must be considered as a source of difference in individuals' intellectual endowments, as must environment and experience. This is well established in biology: biologists distinguish between genotype, the genetic blueprint of an organism, and phenotype, the organism's realized attributes, resulting from a combination heredity and environment. Some people have attempted to include race as a biological variable in explaining characteristics such as moral character, initiative, or intelligence. The reason that race is not and cannot be an explanation for inherited difference in such characteristics is that race is not a valid biological variable.

Scientists who study the genetics of human populations analyze the distribution of alleles, the variant forms of a gene that code for alternate characteristics such as blue or green eyes. The distribution of these alleles varies across different populations. But an individual genome is composed of thousands of genes. For the concept of biological races to be valid, there would have to be significant correlations between the distribution of alleles. Nor does the correlation of allele distributions for any two

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genes suffice; it would be necessary to find correlations across many genes. This does not occur! Further, allele distributions do not line up with the differences in skin color or facial morphology that we take to indicate boundaries of race.

This leaves the other part of the equation for phenotype—environment and experience. Race is not a biological category but a social one, and as such affects people's behavior towards others. If blacks and whites and yellows and reds perform differently on intelligence tests, the scientific approach is not to posit theories of racial inheritance but of racial experience, which is a product of people's belief in races and their stereotyped reactions, both in the present and across time.

Bellamy asks what the chances are of a headhunter winning a Nobel prize. There are many people only a few generations removed from "savage" ancestors now taking graduate degrees. It is a matter of interests, values, institutions, and opportunities, not "race".

Stan, there is good science on this question, which is arguably as important to humanity's future as wormholes and pulsars. While I treasure *Analog* as it is and would not ask for a change in basic format, I think it would be worthwhile to include an occasional science-fact article on this and other important areas of research outside of physics and astronomy.

JIM HESS

As any reader can easily confirm, we do *publish articles outside physics and astronomy—e.g., the day I got this letter, I looked at the last four issues and found four consecutive fact articles in four quite different areas of biology. Of course, with only eleven issues a year, we'll never be able to cover as many areas as we'd like to, but we're always interested in expanding the range of what we do cover. Anyone interested in writing an article should query about the topic and request our guidelines for fact articles.*

Dear *Analog*,

Avoidance of thought about uncomfortable topics has been described rigorously (e.g., Irving L. Janis and Leon Mann, "Decision Making", *The Free Press*, 1977) and humorously (e.g., Scott Adams, "Dilbert"). Dismissing a concept out-of-hand has always been a favorite method. Fortunately, there have always been a few wryly heretical publications willing to discuss the Emperor's clothes and *Astounding/Analog* has always been one of my favorites.

Throughout my thirty-four year career as an engineer, I have solved many problems by looking at them in out-of-the-ordinary ways. A talent abetted in no small way when I began reading *Astounding* under the covers with a flashlight when I was around eleven. In later years I didn't need to use the flashlight, I could stay up as late as I wanted, but the broadening of my viewpoints never waned.

There are times when I think that some of your science-fact writers have totally taken leave of their senses, and other times when I am enthralled by the sensibility of their statements. But, never have I felt anything but admiration for the breadth of thought that the magazine has demonstrated from the day that I first began reading it.

I have always believed that *Astounding/Analog* held some credit for my successful engineering career. Your editorial, "Defenders of the Faiths," explains why. Please don't ever stop.

SAM BRUNSTEIN
Glendale, CA 91206 ■

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UPCOMING EVENTS Anthony Lewis

3–6 September 1998
DRAGON*CON (Atlanta area multi-media conference) at Hyatt Regency, Atlanta, GA. Many guests; TM—Anthony Daniels. Registration—$40 until 31 March 1998, more thereafter. Info— Dragon*Con 1998, PO Box 47696, Atlanta, GA 30362-0696; (770) 925-0115. Email—dragoncon@dragoncon.org; URL—http://www.dragoncon.org

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4–6 September 1998
CONFLUENCE '98 (Pittsburgh area SF conference) at Sheraton Inn, Mars, PA. Guest of Honor—Nancy Kress. Registration—$35 (payable to PARSEC). Info—ConFluence '98, PO Box 3681, Pittsburgh, PA 15230-3681.

4–6 September 1998
FANTASY WORLDS FESTIVAL (Bay Area fantasy conference) at Berkeley Marina Marriott, Berkeley, CA. Guest of Honor—Barbara Hambly; Artist Guest of Honor—Alicia Austin; Fan Guest of Honor—Judy Gerjuoy. Registration—$35 until 1 June 1998, $50 thereafter (attendance limited to 500). Info—Fantasy Worlds Festival, Box 249, Berkeley, CA 94701; URL—http://www.mzbfm.com/fwf/html

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18–20 September 1998
NOTJUSTANOTHERCON 14 (Central Massachusetts SF conference) at Campus Center Hotel, Amherst, MA. Guest of Honor—Terry Bisson; Artist Guest of Honor—Bob Eggleton. Registration—$13 until 1 September 1998, $18 at the door ($5 student discount), children under 8 free. Info—S.C.U.M., RSO 16 UMass, Amherst, MA 01003; Email—scum@stuaf.umass.edu; URL—http://www.umass.edu/rso/scum/

18–20 September 1998
MOSCON 20 (Idaho SF conference) at University Inn, Best Western, Moscow, ID. Guest of Honor—Kevin J. Anderson. Info—MosCon 20, PO Box 9622, Moscow, ID 83843; URL—http://community.palouse.net/moscon/

2–6 September 1999
AUSSIECON THREE (57th World Science Fiction Convention) at World Congress Centre, Melbourne, Australia. Guests of Honour—George Turner (in memoriam), Gregory Benford, Bruce Gillespie. Registration—$155 (A$200), supporting $35 (A$45). (These are the latest posted rates as of the time this column went to press.) This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info—Aussiecon Three, GPO Box 1212K, Melbourne VIC 3001, Australia; US Agent—PO Box 266, Prospect Heights, IL 60070-0266; URL—http://www.aussiecon3.worldcon.org■

Convention runners: If your convention has a telephone, FAX, email, or Web page URL, please let us know so that we can publish this information.

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TECHNOLOGY UPDATE

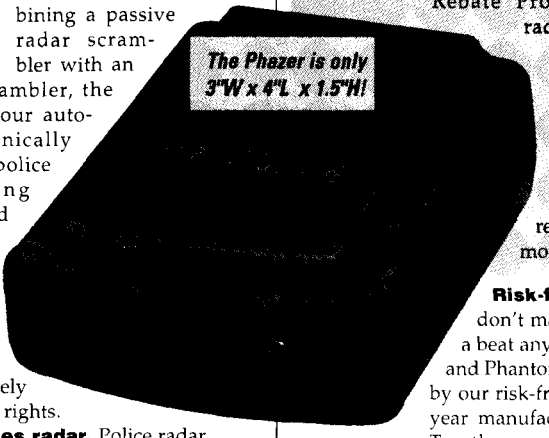
How to make your car invisible to radar and laser

Rocky Mountain Radar introduces a device guaranteed to make your car electronically "invisible" to speed traps—if you get a ticket while using the product, the manufacturer will pay your fine!

As speed-detection technology has gotten more and more advanced, speeding tickets have become virtually unavoidable. And although devices exist that enable motorists to detect these speed traps, they are outlawed in many states... including mine.

■ ***The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.***

The solution. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment. And unless you are a resident of Minnesota, Oklahoma or Washington, D.C., using the Phazer is completely within your legal rights.



How it scrambles radar. Police radar takes five to 10 measurements of a vehicle's speed in about one second. The Phazer sends one signal that tells the radar the car is going 15 m.p.h. and another signal that the car is going 312 m.p.h. Because police radar can't verify the speed, it displays no speed at all.

Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication of the car's distance, blocking measurement of your speed.

Encourage responsible driving. While the Phazer *is* designed to help you (and me) avoid speed traps, it *is not* intended to condone excessive speeding. For that reason, within the first year, the manufacturer will pay tickets where the speed limit was not exceeded by more than 30%, or 15 miles per hour, whichever is less.

Double protection from speed traps. If the Phazer sounds good, but you prefer to be *notified* when you are in range of a police radar, the Phantom is for you. The Phantom combines the Phazer (including the Ticket Rebate Program) with a radar detector. It's legal in every state except Minnesota, Oklahoma, Virginia and Washington, D.C. Ask your representative for more details!

Risk-free. Speed traps don't make my heart skip a beat anymore. The Phazer and Phantom are both backed by our risk-free trial and three-year manufacturer's warranty. Try them, and if you're not satisfied, return your purchase within 90 days for a "No Questions Asked" refund.

The Phazer:
Three credit-card payments of $66.50 $14 S&H

The Phantom:
Three credit-card payments of $116.50 $18 S&H

Please mention promotional code **2546-13390.**

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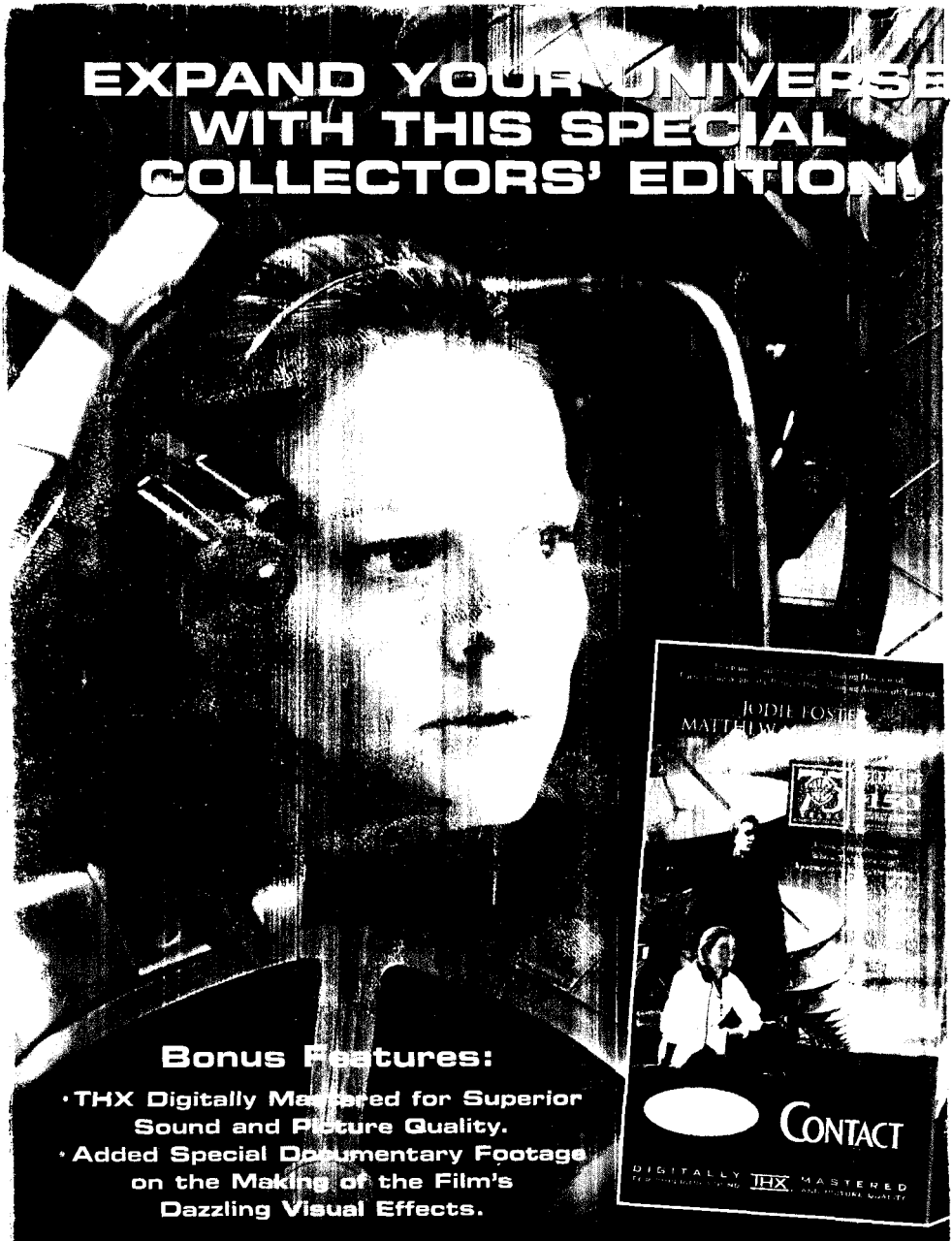

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- THX Digitally Mastered for Superior Sound and Picture Quality.
- Added Special Documentary Footage on the Making of the Film's Dazzling Visual Effects.

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Director of Photography ED VERREAUX Written for the Screen by DON BURGESS, A.S.C. Co-Producers CARL SAGAN and ANN DRUYAN
Executive Producers JOAN BRADSHAW and LYNDA OBST Based on the Story by CARL SAGAN and ANN DRUYAN Screen Story by the Novel by CARL SAGAN
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THX PG

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